PROCEEDINGS

OF THE

ROYAL SOCIETY OF EDINBURGH.

VOL. III. 1853–54. No. 44.

Seventy-First Session.

Monday, 5th December 1853.

Sir T. M. BRISBANE, Bart., President, in the Chair.

The following Communications were read :—

1. Remarks on the Torbanehill Mineral. By Dr Traill.

The Torbanehill mineral is so very peculiar that I cannot call it either a bituminous shale or a coal, to both of which it has a considerable resemblance.

After comparing it carefully with a great variety of English and Scottish coals, and with many varieties of bituminous shale, I conclude that it is a mineral hitherto undescribed by systematic mineralogists, and propose for it the name of Bitumenite.

It appears to me to have been formed by the impregnation or injection of shale with liquid bitumen. Its colour is blackish-brown. Its specific gravity $= 1{\cdot}284$.

I compared it carefully with several specimens of English *cannel* and common coal, and with thirteen varieties of Scottish *parrot* or cannel coal, and other coals of this kingdom, from all of which it differed much in mineralogical characters.

1. When its thin edges are examined by a strong light, or when very thin slices are inspected in the usual way, it is translucent, transmitting a reddish-brown light, whereas coal is opaque on the thinnest edges.

2. Its fracture, though conchoidal, is perfectly dull in every direction.

3. Its streak is not shining, but quite dull.

4. It changes colour strongly in the streak, which exhibits a distinct pale ochre yellow.

5. It breaks with some difficulty, especially in the cross fracture, and exhibits some degree of elasticity. It is, therefore, not brittle.

6. It ignites very readily, and gives out much light; but when this expires, as it soon does, the remaining mass with great difficulty affords the redness of ignition, as observed in coal under similar circumstances; and it retains its form, though it becomes white by incineration.

It consists of volatile matter from 72·5 to 84·1 per cent.
White solid residue, 27·5 to 15·9 ...

It affords a large quantity of fine combustible gas, and also, on distillation, yields much *paraffine*.

It occurs in a bed in the coal formation, associated with shale and ironstone, in the county of Linlithgow, near Bathgate.

The Central Board of Customs of the German Zollverein, assisted by the principal mineralogists of Berlin, have, since this paper was written, decided that the Linlithgowshire mineral is not a coal, and may be imported duty-free, which coal is not.

2. Notice of the Blind Animals which inhabit the Mammoth Cave of Kentucky. By James Wilson, Esq.

The author commenced with a general sketch of the natural character and condition of the great cave, as it is the peculiarities of their local position which constitute the most remarkable feature in the history of the animals by which it is inhabited. The cave descends through the uppermost rocks of the "Barrens" to those which are nearly or quite upon a level with the Ohio. Though called a cave, it is in fact a series of underground galleries, branching from and inosculating with each other in various directions, the

total length of windings being almost incalculable, and even the direct distance from the entrance to the termination extending many miles. The temperature of these inland galleries is uniformly 59° of Fahrenheit all the year round ; and a current of air is very perceptible near the mouth, proceeding outwards or inwards according as the temperature of the external air is greater or less than that of the subterranean region. The air within is uniformly pure, even exhilarating; and this is attributed in a large measure to the great beds of nitre which disengage oxygen during the formation of nitrate of lime. The general boundaries of the caverns are of limestone.

Of the mammiferous animals described as inhabitants of these caverns, there are two species of bat and one species of rat, the latter being confined to, and characteristic of, the locality. If not blind, its organs of vision are very defective.

Two species of fish were noticed, of one of which, *Amblyopsis spelæus* of Dekay, specimens were exhibited. It is totally blind, possessing not even rudimentary organs of sight, dissection having shewn that the optic nerve, and other essential parts, are wanting.

Of the crustaceous tribes a blind cray-fish, *Astacus pellucidus* of Tellkampf, was exhibited. The peduncle of the eye exists, but the actual organ of sight is absent. The observance of this eyeless peduncle had misled some observers into the belief that the creature was not blind.

Various kinds of arachnides, of true insects, and of animalcular species, the majority of them quite blind, were then noticed in the order of their position in systematic arrangements.

The author concluded by referring to the difficulties which beset the theoretic question, as to whether these creatures were blind from their creation, or whether certain species, originally endowed with sight, had wandered by some mischance into those darksome depths, and in the course of ages had lost the organs of a sense, the functions of which they could no longer exercise.

The following Gentleman was duly elected an Ordinary Fellow:—

Græme Reid Mercer, Esq., Ceylon Civil Service.

The following Donations to the Library were announced:—

Memoirs of the Royal Astronomical Society. Vol. XXI., Parts & 2. 4to.—*From the Society*.

Proceedings of the American Association for the Advancement of Science. Sixth Meeting, held at Albany (N. Y.) August 1851. 8vo.—*From the Association.*

Abhandlungen der Königlichen Gesellschaft der Wissenschaften zu Göttingen. V. Band. für 1851 & 1852. 4to.—*From the Society.*

Mémoires de l'Academie des Sciences de l'Institut de France. Tome XXIII. 4to.—*From the Institute.*

Abhandlungen der Philosoph.-Philologischen Classe der Königlich Bayerischen Akademie der Wissenschaften. Band XVII., 1ste Abtheil. 4to.—*From the Academy.*

Nouveaux Mémoires de la Société Helvétique des Sciences Naturelles. Tome XII. 4to.

Mittheilungen der Naturforschen Gesellschaft in Bern. 1851. Nr 195–257. 8vo.

Verhandlungen der Schweizerischen Naturforschenden Gesellschaft bei ihrer 36sten versammlung in Glarus. 1851. 8vo.—*From the Society.*

Denkschriften der Kaiserlichen Akademie der Wissenschaften. Mathematisch-Naturwissenschaftliche Classe. Bde 4 & 5. 4to.

Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften. Mathematisch-Naturwissenschaftliche Classe. Bde 9 & 10. 8vo. —*From the Academy.*

Abhandlungen der Kaiserlich Geologischen Reichsanstalt. Band. I. 1852. Fol.—*From the Institute.*

Astronomical and Meteorological Observations made at the Royal Observatory, Greenwich, in the year 1851. 4to.—*From the Royal Society.*

The Assurance Magazine and Journal of the Institute of Actuaries. Nos. 12 & 13. 8vo.—*From the Institute.*

Journal of the Asiatic Society of Bengal. Edited by the Secretaries. Nos. 230-234. 8vo.—*From the Society.*

Journal of the Geological Society of Dublin. Vol. V., Part 3. 8vo. —*From the Society.*

Journal of the Horticultural Society of London. Vol. VIII., Parts 2 & 3. 8vo.—*From the Society.*

Journal of the Statistical Society of London. Vol. VI., Parts 1, 2, & 3. 8vo.—*From the Society.*

The Quarterly Journal of the Geological Society. Vol. IX., Parts 2 & 3. 8vo.—*From the Society.*

Journal of the Royal Asiatic Society of Great Britain and Ireland. Vol. XV., Part 1. 8vo.—*From the Society.*

The Journal of Agriculture, and the Transactions of the Highland and Agricultural Society of Scotland. No. 41 (N. S.) 8vo. —*From the Society.*

The Twentieth Annual Report of the Royal Cornwall Polytechnic Society. 1852. 8vo.—*From the Society.*

The American Journal of Science and Arts. Nos. 44, 45, & 46. 8vo.—*From the Editors.*

Transactions of the Pathological Society of London. Vol. IV. 8vo. —*From the Society.*

Memoirs of the Literary and Philosophical Society of Manchester. 2d Series. Vol. X. 8vo.—*From the Society.*

Catalogue of the Birds in the Museum of the Asiatic Society of Bengal. By Edward Blyth. 8vo.—*From the Society.*

Transactions of the American Philosophical Society, held at Philadelphia, for promoting Useful Knowledge. (N. S.) Vol. X., Part 2. 4to.—*From the Society.*

Observations made at the Magnetical and Meteorological Observatory at Hobart Town, in Van Diemen Island. Printed by order of Her Majesty's Government, under the superintendence of Colonel Edward Sabine. Vol. III. 4to.

Observations made at the Magnetical and Meteorological Observatory at Toronto, in Canada. Printed by order of Her Majesty's Government, under the superintendence of Colonel Edward Sabine. Vol. II. 4to.—*From Her Majesty's Government.*

Observations made at the Magnetical and Meteorological Observatory at Bombay. Printed by order of the Honourable East India Company, under the superintendence of Arthur Bedford Orlebar, M.A. 1845, 1846, 1847, & 1848. 4to.—*From the Hon. East India Company.*

Abhandlungen der Königlichen Akademie der Wissenschaften zu Berlin. 1852. 4to.

Monatsbericht der Königl. Preuss. Akademie der Wissenschaften zu Berlin. November 1852—Juli 1853. 8vo.—*From the Society.*

Monday, 19*th December* 1853.

SIR T. M. BRISBANE, Bart., President, in the Chair.

The following Communications were read:—

1. Additional observations on the Diatomaceous Earth of Mull, with a notice of several new species occurring in it, and Remarks on the value of Generic and Specific Characters in the Classification of the Diatomaceæ. By William Gregory, M.D., Professor of Chemistry.

The author, after mentioning his previous communications on this subject, stated, that continued investigations of the deposit had yielded the extraordinary number of about 150 species of Diatomaceæ, and that as several of these had been only recently observed, it was nearly certain that more yet remained.

Of these species, from 12 to 15 appear to be undescribed, and there are also 7 or 8 new to Britain, or not hitherto admitted as British species.

The following list contains the names of 118 known and described species occurring in the Mull deposit:—

List of admitted British Species of Diatomaceæ found in the Mull Deposit up to 30*th November* 1853.

1. Epithemia turgida.	22. Cyclotella Kützingiana.
2. „ Zebra.	23. „ antiqua.
3. „ argus.	24. „ Rotula.
4. „ ocellata.	25. Surirella biseriata.
5. „ alpestris.	26. „ linearis.
6. „ ventricosa.	27. „ splendida.
7. „ gibba.	28. „ nobilis.
8. Eunotia gracilis.	29. „ Craticula.
9. „ triodon.	30. „ Brightwellii.
10. „ tetraodon.	31. „ minuta.
11. „ Diadema.	32. „ ovata.
12. Cymbella Ehrenbergii.	33. Tryblionella marginata.
13. „ cuspidata.	34. „ augusta.
14. „ affinis.	35. Cymatopleura spiculata.
15 „ maculata.	36. „ Solea.
16. „ Helvetica.	37. „ elliptica.
17. „ Scotica.	38. Nitzschia sigmoidea.
18. Amphora ovalis.	39. „ linearis.
19. Cocconeis Placentula.	40. „ sigma.
20. „ flexella (Thwaitesii).	41. „ amphioxys.
21. Coscinodiscus excentricus.	42. „ minutissima.

43. Navicula rhomboides.
44. „ serians.
45. „ affinis.
46. „ dicephala.
47. „ firma.
48. „ ovalis.
49. „ obtusa.
50. „ Semen.
51. „ gibberula.
52. „ angustata.
53. „ pusilla.
54. „ tumida.
55. „ inflata.
56. „ crassinervia.
57. Pinnularia major.
58. „ viridis.
59. „ acuminata.
60. „ nobilis.
61. „ cardinalis
62. „ oblonga.
63. „ divergens.
64. „ acuta.
65. „ gibba.
66. „ Tabellaria.
67. „ lata.
68. „ alpina.
69. „ mesolepta.
70. „ interrupta.
71. „ radiosa.
72. „ gracilis.
73. „ viridula.
74. „ stauroneiformis.
75. Stauroneis Phœnicenteron.
76. „ gracilis.
77. „ anceps.
78. „ linearis.
79. „ dilatata.
80. „ acuta.
81. Pleurosigma attenuatum.
82. Synedra biceps.
83. „ radians.
84. „ fasciculata.
85. „ ulna.
86. „ capitata.
87. „ delicatissima.
88. „ Vancheriæ ?
89. Cocconema lanceolatum.
90. „ cymbiforme.
91. „ Cistula.
92. „ parvum.
93. Gomphenema coronatum.
94. „ constrictum.
95. „ capitatum.
96. „ dichotomum.
97. „ acuminatum.
98. „ Vibrio.
99. „ tenellum.
100. Himantidium majus.
101. „ Arcus.
102. „ bidens.
103. „ gracile.
104. „ pectinale.
105. „ undulatum.
106. Fragillaria capucina.
107. Odontidium Tabellaria.
108. Denticula tenuis.
109. Tetracyclus lacustris.
110. Tabellaria fenestrata.
111. „ ventricosa.
112. „ flocculosa.
113. Melosira varians.
114. „ arenaria.
115. Orthosira nivalis.
116. „ aurichalcea.
117. Collatonema vulgare.
118. Diatoma vulgare.

The following are new to Britain, or now first distinguished from others :—

1. Epithemia gibberula.
2. Eunotia bigibba, *Kütz.*
3. „ Camelus, *Kütz.*
4. „ depressa, *Kütz.*
5. Navicula lævissima.
6. „ Trochus.
7. Cocconema gibbum.
8. Himantidium exiguum, *Bréb.*

Of these 8 species, figures were exhibited ; and in the case of Eunotia bigibba a number of striking varieties were figured, and compared with several varieties of Himantidium bidens, with which it had hitherto been confounded.

The author then proceeded to describe and illustrate by figures the following species, most of which are new to science :—

1. Eunotia incisa, *n. sp.*
with 2 varieties.
2. Pinnularia latestriata, *n. sp.*
2 varieties.
3. Cymbella , *n. sp.*
4. Gomphonema Brebissonii, *n. sp.?*
5. „ hebridense, *n. sp.*
6. Stauroneis rectangularis, *n. sp.*
7. Pinnularia exigua, *n. sp.?*
8. „ undulata, *n. sp.*
9. „ parva, *n. sp.?*
10. „ tenuis, *n. sp.*
11. Tryblionella augustata ?
3 varieties of this known species, if not of a new one.
12. Navicula spiculata, *n. sp.*
Discovered by the Rev. W. Smith, in the living state at Grasmere, but not yet described. The author also found it in the Mull deposit.
13. Pinnularia divergens ?
Several very remarkable varieties which the author referred, with some doubt, to this species, lately established by Mr Smith.

Having thus described about 140 species in the above three categories, the author stated, that some additional forms, not yet precisely determined, would have to be added to each; and he next proceeded to make some general remarks on the value of generic and specific characters in the Diatomaceæ.

He showed that some genera had been established on apparently insufficient grounds; thus, Eunotia is separated from Himantidium, because the latter occurs in chains, the former solitary. But Eunotia tetraodon is found in chains, both alive and in this deposit; and if we transfer it to Himantidium, we separate it from Eunotia Diadema, to which it is so closely allied. The author concluded that these two genera should be united.

Again, Cocconema is separated from Cymbella by the former having a stipes, the latter not. But this seems a very slight foundation for a genus where the frustules cannot otherwise be distinguished, as in this case; and here also the author would unite the two genera.

In regard to specific characters, the author showed that those usually resorted to, such as form, size, number, and arrangement of striæ, &c., are subject, in certain species, to almost unlimited variation, of which he gave a striking example in Eunotia triodon, and others in Pinnularia divergens, Eunotia bigibba, and Himantidium bidens. In other cases, again, the species never varies except to a small degree in size. This was shown in Eunotia tetraodon and E. Diadema, and mentioned as occurring in Epithemia gibba, Navicula serians, Amphora ovalis, Pinnularia alpina, P. lata, and many others. It therefore appears that the tendency in a species to vary may be regarded as itself a specific character, as may also the absence of this tendency.

With regard to the actually admitted genera and species, the

author expressed the opinion, that so long as new forms are daily discovered (and that this is the case he proved by many recent examples), we are liable to err in establishing both genera and species. He therefore recommended the collection and figuring of all such forms as appear distinct, to which, of course, provisional names must be given, with a view to the future employment of these materials, when new forms shall have become rare, in ascertaining the true natural groups, whether generic or specific.

The author took occasion, from the occurrence of the permanence of characters above alluded to in many species, to combat the view of Professor Kützing, according to whom, species, as natural groups, do not exist.

Finally, he stated, that the remaining forms would be described in a future communication.

2. On the Physical Appearance of the Comet 3, of 1853. By Prof. C. Piazzi Smyth.

Referring to the general descriptions which had been published in scientific journals and elsewhere of the appearance of this comet, the author pointed out,—1*st*, That the colour which had been attributed to it was merely the adventitious tint due to the twilight atmosphere through which it was seen. 2*dly*, That what had been described as the nucleus of the comet, and of so many thousand miles in diameter, nine days before the perihelion passage, was merely the head, composed of the same light, vaporous transparent matter as the tail; and subject to the same remarkable compression and condensation on approaching the sun.

This condensation had not been sufficiently attended to by cometary observers; but, nevertheless, rendered it absolutely necessary, in giving the size of any comet, to state at what part of its orbit the body might be at the time. The now well recognized fact of such condensation, combined, of course, with the stronger illumination of the sun at a less distance, also gave the best, if not the only, sufficient explanation of the remarkable increase in brightness of some comets about the time of their perihelia.

Moreover, the accurate observation of the amount of such condensation, depending as it does mainly on the proportion between the aphelion and perihelion distances, might lead in many cases to

an approximate knowledge of the former important element, which is generally indeterminable from ordinary observations at a single apparition.

No very careful measures appear to have been made of the compression experienced by the present comet; but contrasting such as have been procured during a month before the perihelion passage, with Mr Hartnup's important daylight observation on that occasion, a period may be anticipated of certainly more than 180 years.

Tuesday, 3d January 1854.

Right Rev. BISHOP TERROT, Vice-President, in the Chair.

The following Communication was read:—

On the supposed Sea-Snake, cast on shore in the Orkneys in 1808, and the animal seen from H.M.S. Dædalus, in 1848. By Dr Traill.

The discussions which arose about four years ago on the animal reported to have been seen on 6th August 1848, by Captain M'Quhae, the officers and crew of H.M.S. Dædalus, in the Southern Atlantic, between the Cape of Good Hope and St Helena, about 300 miles off the African shore, recalled my attention to the materials I had collected respecting the vast animal cast ashore on Stronsey, one of the Orkneys, in 1808.

I was not there at the time, but copies of the depositions made by those who had seen and measured it were transmittted to me by order of Malcolm Laing, Esq., the historian of Scotland, on whose property it was stranded; and I obtained other notes from several individuals resident in Orkney.

The evidence of the most intelligent persons who had seen and measured the animal was carefully collected, and copies of it were transmitted by Mr Laing to Sir Joseph Bankes, and other naturalists. Soon afterwards Mr Laing sent, through his brother, the late Gilbert Laing Meason, to the museum of our university the skull and several vertebræ. The cartilaginous omoplates, to which a portion of the pectoral fin, or *wing*, as it was termed by the natives, were afterwards sent to Edinburgh, where I saw and examined them.

Two of the vertebræ were transmitted to me, with portions of what was termed the *mane* of the animal; which I now exhibit.

The dead animal was first observed by some fishermen lying on a sunken rock, about a quarter of a mile from Rothiesholm-head; but in a few days a violent gale from the S.E. cast it on shore in a creek near the headland, where it remained for some time tolerably entire; and it was subsequently broken up by the fury of the waves. Before it was thus broken into several pieces it was examined, and measured by several intelligent inhabitants of the island; and their testimony, collected as above stated, was forwarded to London, Edinburgh, &c. Their declarations were, however, accompanied by a very absurd suppositious drawing of the animal, which was thus produced. Many days elapsed ere the tempestuous weather allowed any communication with other islands; and when the storm abated, a young man was sent from Kirkwall by Mr Laing, to collect what information he could on the subject. But by this time the body of the animal was completely broken up. This lad, who was no draughtsman, and ignorant of Natural History, endeavoured, from the descriptions of those who had seen the animal most entire, to delineate with chalk on a table a figure of the animal. The rude figure so produced was transferred by pencil to paper, and copies of it were handed about as real representations of the animal.

That it had a general resemblance to the animal was admitted by those who had seen it; but from the accounts I afterwards obtained, it would appear that the *jointed legs*, which the lad had attached to it, are creations of his own imagination.

The appendages, which gave rise to this strange representation, were never called *legs* by those who saw the animal, but were denominated by them *wings*, or *fins*, or *swimming paws*. "That nearest the head was broader than the rest, about four-and-a-half feet in length, and was edged all round with bristles or fibres, about ten inches long." The "lower jaw was wanting when it was cast ashore, but there remained cartilaginous teeth in portions of the jaws." Before it was discovered putrefaction had commenced, especially in the *fins*. The animal had a long and slender neck, on which there were two spiracles on each side.

The *wings* would seem to have been the remains of fins, altered by incipient decomposition. The six may perhaps be remains of pectoral, abdominal, and anal fins, and perhaps they may have been

placed, like those of some of the shark family, farther from the centre of the abdomen than in ordinary fishes. Indeed one of the witnesses states that "the wings of the animal were jointed to the body nearer the ridge of the back than they appear in the drawing."

The portion of the anterior fin or *wing*, which was attached to the omoplates, consisted of cartilaginous rays; and when such a structure of fin is partially separated by commencing decomposition, the rays might easily, to the eyes of the uninitiated in natural science, seem like toes or fingers.

Even the great Cuvier admits this resemblance, when describing the fins of fishes:—

"Des rayons plus ou moins nombreux soutenant de nageoires membraneuses, representent grossièrement les doigts, des mains, et des pieds."

As much of the value of the descriptions of the Orkney animal rests on the character and credibility of the individuals who saw it most entire, I may be permitted to state that I personally knew the three principal witnesses, Thomas Fotheringhame, George Sherar, and William Folsetter, to be men of excellent character, and of remarkable intelligence. They were not *ignorant fishermen*, as the witnesses were represented to be; but two of them were of the better sort of farmers in that part of Orkney; and the first and the last of them were also very ingenious mechanics, much accustomed to the use of the *foot-rule*, the instrument employed in measuring the animal.

They were men of such honour, intelligence, and probity, that I can have no doubt of the correctness of any statement they made of their impressions of what they had so carefully observed.

It was, therefore, not without surprise, that some months after these accounts were sent to London, I read a paper by Mr Home (afterwards Sir Everard), in which he recklessly sets aside the evidence of the persons who saw and measured the animal in its most entire condition, as to its dimensions of length and thickness; and maintains that it was nothing but a Basking shark (*Selache maximum !*), which he supposes the love of the marvellous had magnified so enormously in the eyes of those whom he is pleased to call "*ignorant fishermen.*" Unfortunately for Home's hypothesis, the Basking shark was probably far more familiar to those men than to himself; for it is often captured among the Orkney islands; and its

length and proportional thickness are so totally different from the animal in question, that the two could scarcely be confounded, by the most "ignorant fishermen" who had ever seen them.

These witnesses assert that the Stronsey animal (though a portion towards the tail was broken off when they took its dimensions) measured no less than fifty-five feet in length; whereas that of the largest Basking shark of which we possess any accurate account, scarcely exceeds thirty-six feet.

The circumference of the two animals is no less widely different. My notes state the circumference at the thickest part of the body of the Orkney animal to be about ten feet; while it tapered much towards the head and the tail; whereas the circumference of a large Basking shark, where thickest, is not less than twenty feet. Besides, the shark-like figure of the latter could scarcely be confounded with the eel-like form of the Stronsey animal.*

The *mane*, as it is termed, may perhaps be the remains of a decomposed dorsal fin; but the fibres do not seem to be the rays of a fin; and the animal seen from the *Dædalus* is stated to have had a mane, floating about like sea-weed; and a similar appendage has generally been noticed in some less distinct accounts of a supposed sea-serpent.

Supposing this to be a dorsal fin, it extended from the anterior *wings*, or pectoral fins, towards the tail for thirty-seven feet, and differs from the dorsal fin of any species of shark. If the *mane* consisted of detached fibres extending for thirty-seven feet on the back, it is analogous to no appendage of any known marine animal. That its rays or fibres are very peculiar, will appear from the specimen now exhibited. These round fibres are fourteen inches in length; and in the dried state, have a yellow colour and transparency, equal to that of isinglass.

The vertebræ, which have been preserved in spirit in our Museum, have been exceedingly well described by Dr Barclay, in the Wer-

* The diameter of the animal is a little differently stated by different witnesses. But as we are told that its contour was more oval than round, we can easily explain the discrepancy. One witness, who had not measured it, speaks of it as equalling a middle-sized horse in thickness. On measuring four horses of from thirteen to fourteen hands in height, I found their greatest circumference to be from seventy-one to seventy-three inches, (or from five feet eleven inches to six feet one inch), or an average of six feet; that is less than the thickest part of our animal, but seemingly near that of its average dimensions.

nerian Transactions, vol. i.; and undoubtedly, in their want of processes and cartilaginous structure, have much resemblance to those of chondropterygious fishes. One of the vertebræ adherent to the cranium, measured only two inches across; while that of the Basking shark, in the same situation, is about seven inches in diameter. Dr Barclay's paper is accompanied by an engraving of the omoplates, and upper portion of the pectoral fin, which are accurately given, from a drawing made from the recent remains, by the late Mr John T. Urquhart, an accomplished draughtsman, and able naturalist. I know the representation to be correct, for I saw and handled the specimen. The substance of this part was a firm, but flexible cartilage, and seemed to have been placed in the muscles; just as Cuvier describes the omoplates of sharks to be: "Leur omoplates sout suspendues dans le chair, en arrière des Branchies, sans articuler ni au crâne ni à l'espine."

The Orkney animal seems to have had *two circular* spiracles on each side of its neck, about $1\frac{1}{4}$ inch in diameter; whereas the Basking shark has *five linear* spiracles on each side, a foot or more in length.

The cranium, which I also very carefully examined, was far too small for that of a Basking shark of even one-fourth the usual length of that species. It measured in its dried state no more than twelve inches in length, and its greatest diameter was only seven inches. A Basking shark of thirty-six feet long would have had a head of at least five feet in length; and the diameter of the cranium, at the angles of the mouth, would have measured probably five feet. These proportions positively shew, that the Orkney animal could not possibly be confounded by intelligent men, accustomed to see the Basking shark, with that fish. There was a hole on the top of the cranium, something similar to the blow-hole of the cetaceans; but its lateral spiracles and cartilaginous bones forbid us to refer it to the order of cetacea.

Everything proves the Orkney animal to have been a chondropterygious *fish*, different from any described by naturalists; but it has no pretensions to the denomination of *Sea-serpent* or *Sea-snake*, although its general form, and probably its mode of progression in the ocean, may give it some resemblance to the order of *Serpentes*. Certainly, it cannot be confounded with any known shark; nor does it belong to the family of Squalidæ.

The belief in the existence of a huge marine animal, of an enormous length, which has obtained the name of *Sea-serpent*, is still very general among the Norwegian fishermen, and is said to have been seen lately in some of their *fiords*. A singular notice of it was long ago published by Bishop Pontoppidan, in his History of Norway; but, unfortunately, in his pages, it was introduced in the suspicious company of the *Kraken* and the *Mermaid;* and therefore has been rejected by later naturalists.

I am satisfied, however, that the extravagant descriptions which northern authors have given of the *Sea-serpent*, have been founded on the rare appearance of some such animal as that driven on shore in Orkney; which may also have been the prototype of the dark sublimity of the wondrous sea-snake of the Scandinavian Edda. That in the ocean such animals do exist, has been affirmed by persons worthy of credit. I shall notice an unpublished instance, related to me many years ago by my intelligent friend, the late Mr Andrew Strang, a gentleman of unblemished honour. "Once, when on a deep-sea fishing, he saw pass below his boat, at the depth of eight or ten feet, an enormously long fish, of an eel-shape. It was swimming slowly, with a vermicular motion, and appeared to be at least sixty feet in length." It appeared to take no notice of them; but they hastily removed from what they considered a dangerous neighbourhood. He stated that he was shy of mentioning this circumstance, "lest the sceptical public should class him with the fable-loving Bishop of Bergen." There is considerable reason to believe that a similar fish has appeared more than once on the western coasts of Scotland.

I shall not here discuss the notices we have, from time to time, received of late years of a great *Sea-serpent* seen by mariners in crossing the Atlantic to America. Their accounts are generally confused, sometimes evidently fabulous; and, in some instances, it would seem that the narrators have mistaken a shoal of porpesses or other delphinoid animals, for a huge sea monster.

The bones exhibited by Koch, at New York and Boston, as those of a fossil *Sea-serpent*, which were afterwards brought to Berlin, have been proved to be a most disingenuous fraud of the finder, who united the bones of different individuals of an extinct species of whale; bones now proved by Professor Muller to belong to animals of very different ages, and by M. Agassiz "to have been dug up at different localities." Several diminutive snake-like animals have

been killed on the shores of America; as that taken at Cape Anne in 1817, which is figured in the *Illustrated London News* of 28th October 1848, from the original American memoir. Neither the *Saccopharynx* of Mitchell, nor the *Ophignathus* of Harwood, can be considered as the animal we have described. The *Saccopharynx* is said to be 4½ feet long; the *Ophignathus* was six feet. Neither of them in size or form will, in the language of Mr Owen, "satisfy the conditions of the problem."

I must except from this category, however, the animal seen from H.M.S. *Dædalus;* and the account of it given by Captain M'Quhae and his officers. In their statements there are no suspicious affectations of minute detail. Their simple narrative appears to deserve more attention than it has yet received from naturalists; and I strongly incline to the belief, that the animal seen by the crew of the *Dædalus* was an analogue of, if not the very same species, as the animal cast ashore in Orkney in 1808.

Considering the derision with which, in this country, the subject of the *Sea-serpent* has been treated, and the ridicule attempted to be thrown on all who were bold enough to assert that they had seen such an animal, nothing but a consciousness of his unimpeachable veracity could have tempted the gallant Captain M'Quhae to encounter the sneers of his incredulous countrymen. From all I have heard of his character for sagacity and veracity, from those who intimately knew him, I have not the smallest doubt that he has faithfully described what he and his crew saw distinctly, and at a short distance from the ship.

The animal seen from H.M.S. Dædalus on 6th August 1848, *in lat.* 24° 44′ S., *long.* 9° 22′ E.—"It was seen rapidly approaching before the *beam.*" Captain M'Quhae says: "On our attention being called to the object, it was discovered to be an enormous serpent, with head and shoulders kept about four feet constantly above the surface of the sea. The diameter of the serpent was about fifteen or sixteen inches behind the head; its colour of a dark brown, with yellowish-white about the throat."

The Captain could discover no fins, but "something like the mane of a horse, or rather a bunch of sea-weed, washed about its back." He thought that its head did certainly resemble that of a snake; but the drawing which he transmitted to the Admiralty has not, to the eye of a naturalist, the form of that of any snake. The

figure published in *The Illustrated London News* for October 28, 1848, is said to be an accurate copy of that drawing.

Captain M'Quhae estimates the length of its body at the surface of the water, "*à fleur d'eau*, at the very least equal to sixty feet, no part of which was to our perception used in propelling it through the water, either by vertical or horizontal undulations. It passed rapidly, but so close under our quarter, that had it been a man of my acquaintance, I should easily have recognized his features with the naked eye; and it did not, either in approaching the ship, or after it had passed our wake, deviate in the slightest degree from its course to the S.W., which it held on at the pace of twelve or fifteen miles an hour, apparently on some determined purpose."

If we may judge from the engraving, the cranium is very convex, of moderate size, with a short obtuse muzzle, a mouth reaching beyond the eye; which last organ is round, and of a moderate size. The surface of the body is represented as smooth, and destitute of scales—of which they were enabled to judge, because it passed close under the *quarter* of the ship. It was in sight for twenty minutes.

The description certainly does not belong to any Ophidian; and as certainly militates against an opinion thrown out by Mr Owen, that it might be a specimen of the *Leonine seal*, which has, it is alleged, occasionally reached those latitudes. The Leonine seal never exceeds twenty-five feet in length, and such would have a circumference at its shoulders of twenty feet, while this appears to be eel-shaped, with a diameter of not more than fifteen or sixteen inches behind the head. The mane, too, of the male of the Leonine seal extends only over the head and neck; but in the other, it extended down the back.

With all deference to so eminent a naturalist as Mr Owen, I humbly conceive that his conjecture respecting the identity of Captain M'Quhae's animal with the Leonine seal, is not more probable than Home's identification of the Basking shark with the Orkney animal.

Both M'Quhae's and the Orkney animal would appear to be cartilaginous fish, totally different from any genus known to naturalists.

2. Further Researches on the Crystalline Constituents of Opium. By Dr Thomas Anderson.

The following Gentleman was elected an Ordinary Fellow :—

Sir JOHN MAXWELL of Poloc, Bart.

The following Donations to the Library were announced :—

Journal of Agriculture, and Transactions of the Highland and Agricultural Society of Scotland. No. 43. N. S. 8vo.—*From the Society.*

Medico-Chirurgical Transactions. Published by the Royal Medical and Chirurgical Society of London. Vol. XXXVI. 8vo.—*From the Society.*

Mémoires de l'Académie Impériale des Sciences de St Pétersbourg. Sciences. Mathématiques et Physiques. Tome V., 5 & 6 Liv. 4to.—*From the Academy.*

Astronomische Beobachtungen auf der Königlichen Universitäts Sternwarte in Königsberg. Angestellt und herausgegeben von Dr A. L. Busche. 25te Abtheilung. Fol.—*From the Observatory.*

Monday, 16*th January* 1854.

SIR T. M. BRISBANE, Bart., President, in the Chair.

The following Communication was read :—

What is Coal? By Dr Fleming.

Dr Fleming, after stating the circumstances which led him to bring before the Royal Society the consideration of this question, pointed out the distinction between a *mineral species* and a *rock*, a circumstance which had been greatly overlooked in recent discussions on the subject. He considered coal as a rock, and capable of being traced, in its origin and history, from peat at the beginning of the series, to blind coal or anthracite at the termination.

He illustrated the character of peat in reference to the vegetables from which it was derived—the changes of a mineralizing nature which it had undergone—and the strata of sand, clay, and marl with which it is usually associated. He likewise pointed out the character of the lustrous streak and conchoidal fracture in specimens exhibited.

The author next proceeded to the consideration of wood coal, or lignite, and exhibited specimens of this rock with and without the woody texture—with a brown and black streak—with a lustrous and dull streak—and with the ligneous structure, and as cherry coal, undistinguishable from the same rock in the older measures. He closed his remarks on the brown coals by adverting to the *coal-money* of the Kimmeridge coal, and to the condition of *amber* as belonging to this epoch.

In the third and concluding part of his paper, he pointed out the characteristic features of the four kinds of coals found in the coal measures. The lustre, fracture, and streak, from exhibited specimens, he demonstrated to be variable and unsatisfactory as characters; while chemical test indicated the absence of bitumen. He adverted to the different kinds of matter occurring in coal as indicated by the microscope, and exhibited specimens of seeds dispersed through splint and cherry coal. He concluded his remarks by adverting to cannel coal, as exhibiting, in its varieties, the conchoidal and slaty fracture, the lustrous and dull surface and streak; and in reference to the Boghead cannel or gas coal, adverted to in this Society as the "Torbanehill mineral," and denominated "bitumenite" by Dr Traill, he considered all the characters employed to remove it from its position as a *cannel coal*, as variable, differing in degree not in kind, and not generally recognised.

The following Gentleman was elected an Ordinary Fellow:—

William Murray, Esq. of Monkland, F.G.S.

Monday, 6*th February* 1854.

Right Rev. BISHOP TERROT, Vice-President, in the Chair.

The following Communication was read:—

Observations on the Structure of the Torbanehill Mineral, as compared with various kinds of Coal. By Professor Bennett.

Monday, 20th February 1854.

JOHN RUSSELL, Esq., P.C.S., in the Chair.

The following Communications were read:—

1. Account of the Proceedings of the Conference held at Brussels in August and September last, for establishing a uniform system of Meteorological Observations in the Vessels of all Nations, and of the arrangements proposed to be made for conducting the results of the Observations taken on Land with those taken at Sea. By Captain H. James, R.E., F.R.S, &c. Communicated by James Wilson, Esq.

2. On certain Vegetable Organisms found in Coal from Fordel. By Professor Balfour.

The author stated that the coal to which he called attention was found at Fordel collieries, near Inverkeithing, Fife, and that he was indebted for specimens of it to Mr Robert Daw, comptroller of customs at Leith. It is a splint coal, and exhibits numerous vegetable impressions, particularly of Sigillaria and Stigmaria. These plants appear, indeed, the author thought, to have formed the main substance of the coal, as shown not only by its external appearance, but also by its microscopical structure. Cellular and woody tissue have long been recognised in coal; but from what is now seen in the Fordel and other varieties, it would appear that scalariform and dotted tissue are often present, and, moreover, that in some instances peculiar dotted vessels have been mistaken for true punctated woody tissue. Elongated cavities, containing yellow and orange-coloured matter, also occur in Fordel coal. These cavities did not appear to be woody tubes, from which they differed in their form and arrangement, as well as in occasionally branching. They seemed in this, as in many other coals, to be more of the character of intercellular spaces or canals. The coal from Fordel also contains numerous specimens of seed-like bodies, which appear to be sporangia, allied to those of Lycopodiaceæ. These bodies have a rounded form; their colour is dark-brown, and they seem to be formed by two valves, which are occasionally separated. When one of the valves is removed, there is frequently ob-

served a black carbonaceous mass below it; and when a transverse section is made of an entire sporangium *in situ*, the cavity between the valves is often evidently seen. At one part of the sporangium a stalk-like process is sometimes observed. These sporangia seem to resemble much those organs of fructification in Lycopodiaceæ which contain the small spores, commonly known as vegetable sulphur or Lycopode powder, and it seems probable that the dark contents of the Fordel sporangia may be the altered spores.

Large spore-like bodies are also met with in coal, which may perhaps be similar to the larger spores of Lycopods. It is by no means improbable, the author thought, that the sporangia in the Fordel and other coals may be the fructification of Sigillaria,—a genus which occupies an intermediate position between Cycadaceæ and Lycopodiaceæ. The Fordel coal also contains abundance of the inflammable resinous organic matter called Middletonite, which, according to the author, may perhaps be in some way connected with the sporangia just noticed.

Specimens were shown of Fordel coal formed by Sigillariæ and Stigmariæ, and of the same coal containing sporangia and Middletonite, while the communication was illustrated by magnified drawings of structure.

The following Gentleman was elected an Ordinary Fellow:—

Dr John Addington Symonds, of Clifton, Bristol.

Monday, 6*th March* 1854.

Sir T. M. BRISBANE, Bart., President, in the Chair.

The following Communications were read:—

1. On the Impregnation of the Ova of the Salmonidæ. By John Davy, M.D., F.R.S. Lond. & Edin., Inspector-General of Army Hospitals.

The author has been induced, he states, to make inquiry on this subject, in consequence of a recent averment, founded on a reported experiment, that the ova of the trout taken from the abdomen of the parent fish, and not afterwards mixed with the milt, have proved prolific.

He first gives an account of many trials made to test the accuracy

of the conclusion that the ova of the Salmonidæ may be impregnated *ab externo*, the results of all which have been negative, and remarkably contrasted with those in which, after exclusion, the milt and roe have been mixed,—impregnation having been effected and the eggs rendered prolific.

Secondly, he notices the generative organs of these fishes, and points out how, anatomically, they are clearly unfit for performing the reproductive function according to the hypothesis of impregnation *ab externo*, though perfectly adapted for it in accordance with the received doctrine.

Thirdly, he adverts to the manner in which, during the spawning season, the male and female fish approach each other, as being also in accordance with the same doctrine, and opposed to the inference of internal impregnation.

In conclusion, he observes, that even admitting the accuracy of the detail of the experiment adduced to prove such a mode of impregnation, the conclusion drawn is not a necessary one,—inasmuch as the ova included in a perforated box and placed in a stream, may have been impregnated by milt shed in the adjoining water, and by it in its flow conveyed to them.

2. Account of a remarkable Meteor seen on 30th September 1853. By William Swan, Esq.

On the 30th September 1853, I was with my friend Mr David Wallace, in a field near his house, Balgrummo, in the neighbourhood of Leven, in Fifeshire. The atmosphere was very clear, and the sun was shining brightly. The sky was covered in some quarters with thin cirrous clouds, and we had been watching the changes in the appearance of the clouds nearly overhead, when Mr Wallace, who was still observing the sky, pointed suddenly upwards, and called on me to look. I did so, and instantly saw a round body, apparently as large as a star of the first magnitude, moving rapidly upwards, —roughly speaking, towards the zenith, or more accurately, towards the sun. This, as I immediately afterwards ascertained, was about 11^{h} 15^{m} Greenwich mean time.

The region of the sky which the meteor traversed was cloudless and serene, so that I had an extremely favourable opportunity of observing it, and I continued to see it for about a second of time.

As it moved upwards through the sky, its apparent magnitude diminished with such perfect regularity until it finally disappeared, that at the time I had the impression that it had vanished, not by dissolution of its parts, or extinction of its light, but only optically, from the effect of increased distance. I do not wish, however, to attach much importance to this nearly momentary feeling, for the observation was of too transitory a nature to make it deserving of much confidence.

The meteor appeared to me not like a self-luminous body; although, in the presence of so bright an object as the sun, negative evidence on such a point cannot be regarded as decisive. Its colour was perfectly white, and its apparent brightness was probably not greater than that of the moon seen under similar circumstances,—certainly it did not exceed that of an ordinary cloud illuminated by the sun.

Mr Wallace, as soon as he had time to recover from the surprise excited by so unusual a spectacle described what he had seen as one of the most beautiful phenomena he had ever beheld. It will be recollected that it was he who first pointed out the meteor to me; and having been the first to notice it, he had thus also been able to observe some interesting changes in its form which I was too late to witness. By his kindness I am enabled to state what he saw in his own words.

"On the forenoon of the 30th September last," he says, "I was in a field distant about five hundred yards from Balgrummo house, and about a mile and three quarters from Leven. The sky was rather free from clouds, and the sun was shining brightly. I happened to look in the direction of Lethem farm-house, when I was startled by observing a remarkable object, apparently traversing the atmosphere with a steady motion resembling that of a balloon, but much quicker. It appeared to me to be not perfectly round, but somewhat pear-shaped; and it had a lustre like quicksilver, but seemed more transparent. Its movement was upwards like a rising balloon, and not downwards like a 'falling star.' I only saw it for two, certainly not for more than three seconds; and its direction, as nearly as I could judge, was from N.E. to S.W. It appeared to preserve its original shape for about half the time during which it remained visible; but it then seemed to burst at the lower part into a number of fragments, which one by one disappeared, until it finally vanished altogether.

Its size at first seemed to be about one-third less than the apparent diameter of the moon; and I could have supposed it to be in our own atmosphere."

From the apparent size of the meteor, and its perfectly round form as seen by me, contrasted with its much greater magnitude as estimated at first by Mr Wallace,—its train,—its separation into fragments,—and its final round form as described by him, coupled with the fact that he saw it for some time before me,—I conclude that I had only seen the meteor in the last of the phases which he describes. It seemed to me to have a very striking resemblance to the shooting stars so frequently visible by night. It was not, indeed, so luminous as such objects usually appear to be; but that was not to be expected in the presence of the sun; and, I have no doubt, had it been seen by night, it would have proved a very brilliant object indeed.

I may add, that the meteor was not accompanied by any sound, and that its path was sensibly rectilinear.

As I hoped to obtain accounts of the meteor as seen from other stations, I deemed it desirable to ascertain, as far as was practicable, the positions of the points in the heavens where its most remarkable phases occurred. In the absence of stars, which by night afford such convenient points of reference, I endeavoured, with Mr Wallace's assistance, to estimate the altitudes and azimuths of the principal points in the path of the meteor; and as soon as I could command time I returned to the spot, in company with Mr Wallace; and by means of a prismatic compass determined the azimuths of these points, while their zenith distances were measured by means of a quadrant, which, although rude, was sufficiently accurate for my purpose. The true azimuths were deduced from those which were observed, by subtracting the variation of the compass, which was found to be 25° 20′ W. The variation was determined from the azimuth of the sun, observed by the compass; the latitude and longitude of the station deduced from data kindly furnished by Captain Henry James, R.E.; and the time given by a pocket chronometer, carried in its box, and compared with the Edinburgh time-ball.

The following are the positions of the most remarkable points in the meteor's path:—

	Apparent Zenith distance.	Azimuth.
Meteor appeared, .	70° 37′	North 2° 59′ East.
Meteor burst, . .	57 40	„ 7 48 „
Meteor disappeared,	47 30	„ 10 49 „

The station where the meteor was seen is situated very nearly in latitude 56° 13′ 5″ N., longitude $12^{m}\ 2^{s}{\cdot}6$ W.

It is worthy of remark, that as the meteor was seen at $11^{h}\ 15^{m}$, Greenwich mean time, if allowance is made for the longitude of the station and the equation of time, it follows that it appeared about 48^{m} before apparent noon, or about that time of day when the sun shines most brightly. Now, while many accounts are extant of meteors which have appeared during the day, and have attracted attention by exploding audibly, or have been accompanied by the descent of meteoric stones, I was not aware that any object like the meteor of the 30th September, resembling so closely the more tranquil phenomena of shooting stars, had been described as being seen within an hour of noon, and in bright sunshine. I was, therefore, desirous of obtaining other observations of the meteor, and for that purpose I sent a short account of it to one of the Edinburgh newspapers, requesting the favour that any observations of it made elsewhere might be communicated to me, in order that they might be incorporated with this narrative. I have not, however, had a single communication on the subject,—a result which, although it is to be regretted, yet does not surprise me; for, from the faint illumination of the meteor, it was an object which would scarcely *attract* observation, although it was easily perceptible to an eye which, like my friend's, was already directed to the region of the sky where it appeared.

3. On the Mechanical Action of Heat. By W. J. Macquorn Rankine, C.E., F.R.SS. Lond. & Edin., &c.

Section VI. *Subsection* 4.—*On the Thermic Phenomenon of Currents of Elastic Fluids.*

Supplement.—Of a Correction applicable to the results of the previous reduction of the experiments of Messrs Thomson and Joule.

In investigating the phenomena of the free expansion of gases in the previous part of this paper, they had been considered as expand-

ing, without receiving or giving out energy in any form; so that the equation taken to represent their condition was

$$\Delta \Psi = 0.$$

This condition was realized in the early experiments of Mr Joule, where, by the sudden opening of a stopcock, air previously confined in one vessel was allowed to fill another also; but it is not exactly realized in the experiments now in progress by Messrs Joule and Thomson, for which the correct equation is

$$\Delta (\Psi + P V) = 0.$$

Hence the approximate positions of the point of absolute cold calculated by means of the former equation, require a small correction. The author computes the values of this correction for two series of experiments, made at a high and a low temperature respectively; and finds them to be—

$+ 0^{\circ}\cdot05$ Centigrade for the high temperature,
$- 0^{\circ}\cdot002$ Centigrade for the low temperature;

so that for the experiments now in question, the correction is practically inapplicable. As it may, however, have a sensible amount for greater ranges of temperature and pressure than those which occur in the particular experiments referred to, and for gases denser than atmospheric air, the author explains how it is to be calculated.

The following Donations to the Library were announced:—

Lectures on Quaternions. By Sir William R. Hamilton. 8vo.—*From the Author.*

Fourth Report of the Council of Management of the Architectural Institute of Scotland. 8vo.—*From the Institute.*

Memoirs of the American Academy of Arts and Sciences, (N. S.) Vol. V., Part 1. With Map of Toronto. 4to.

Proceedings of the American Academy of Arts and Sciences. Vol. II. From May 1848 to May 1852. 8vo.—*From the Academy.*

Journal of Agriculture, and the Transactions of the Highland and Agricultural Society of Scotland. No. 44. (N. S.) 8vo.—*From the Society.*

Journal of the Statistical Society of London. Vol. XVI., Part 4. 8vo.—*From the Society.*

The American Journal of Science and Arts. Conducted by Professors Silliman and Dana. Second Series. No. 49. 8vo.—*From the Editors.*

Journal of the Horticultural Society of London. Vol. IX., Part 1. 8vo.—*From the Society.*

Journal of the Asiatic Society of Bengal. Edited by the Secretaries. No. 5. 1853. 8vo.—*From the Society.*

The Assurance Magazine, and Journal of the Institute of Actuaries. No. 14. 8vo.—*From the Institute.*

Thirty-third Report of the Council of the Leeds Philosophical and Literary Society. 1852–3. 8vo.—*From the Society.*

Jahresbericht über die Fortschritte der reinen, Pharmaceutischen und Technischen Chemie, Physik, Mineralogie und Geologie, &c. Herausgegeben von Justus Liebig et Hermann Kopp. 1847–50. 8vo.—*From the Editor.*

Bulletins de l'Academie Royale des Sciences, des Lettres et des Beaux Arts de Belgique. Tome XX. 8vo.—*From the Academy.*

Flora Batava. 174 Aflevering. 4to.—*From the King of Holland.*

Mémoires Couronnées et Mémoires des Savants Etrangers, publiés par l'Académie Royale des Sciences de Belgique. Tome V. 2de Partie. 8vo. Two copies.—*From the Academy.*

Memorie della Accademia delle Scienze dell' Istituto di Bologna. Tomo III. 4to.—*From the Academy.*

Acta Societatis Scientiarum Fennicæ. Tom. III., Fasciculus 2. 4to. —*From the Society.*

Notiser ur Sällskapets pro Fauna et Flora Fennica Förhandlingar. Pt. 2. 4to.—*From the Society.*

Della Instituzione de' Pompieri, dal Francesco del Giudice. 4to.

Rendiconto delle Sessioni dell' Accademia delle Scienze dell' Istituto di Bologna. 1851–2. 8vo.—*From the Academy.*

Mémoires de l'Académie Royale des Sciences, des Lettres, et des Beaux Arts de Belgique. Tome XXVII. 4to.—*From the Academy.*

Mémoires sur les Variations Périodiques et non Périodique de la Température. Par A. Quételet. 4to.

Observations des Phénomènes Periodiques. Par A. Quételet. 4to. —*From the Author.*

Mémoires de la Société des Sciences Naturelles de Cherbourg. 1er. Vol. 2e Liv. 8vo.—*From the Society.*

A History of the Fishes of Massachusetts. By David Humphreys Storer, M.D., A.A.S. 4to.—*From the Author.*

Maritime Conference, held at Brussels, for devising an uniform System of Meteorological Observations at Sea, August and September 1853. 4to.—*From the Belgian Academy.*

Monday, 20*th March* 1854.

SIR T. M. BRISBANE, Bart., President, in the Chair.

The following Communications were read :—

1. On the Total Invisibility of Red to certain Colour-Blind Eyes. By Dr George Wilson.

After some remarks on the peculiar difficulties which attend investigations into the functions of the eye, the author observed, that by far the most remarkable variety of colour-blindness, in a scientific point of view, is that which shows itself in the identification of red with black. This appeared to have been overlooked by previous observers, or at least only cursorily described. The probable causes of this neglect were noticed; and the author then proceeded to detail the experience of some twelve parties by whom various objects of a red, crimson, or scarlet colour were mistaken for black, and appeared, from the testimony of those who committed the mistakes in question, to have made neither a colorific nor a luminous impression on the retina. It was further shown, that though the fact had not attracted attention, the published cases of colour-blindness supplied examples of the same blindness to red; and that Dalton, although he had apparently ascertained his own freedom from the blindness in question, had incidentally supplied proof that the red alike of the solar spectrum and of coloured objects frequently appeared to him as dark or nearly black.

Experiments were also recorded, which had been made by the author, with the assistance of Professor Kelland, on the visibility of prismatic spectra to persons affected by colour-blindness, one of whom was found unable to perceive from $\frac{1}{8}$th to $\frac{1}{6}$th of the red end of the solar spectrum, whilst the other could not discern $\frac{1}{3}$d of the

red. These parties showed a similar degree of blindness to the red of the lime-ball-light spectrum, and neither of them saw any other colour in place of the missing one, or received a luminous impression from the less refrangible rays of solar or artificial light.

From his entire observations, the author drew the conclusion, that the confusion of scarlet with green, and of pink, crimson, and purple with blue, which characterises the colour-blind, is a phenomenon of the same kind as the confusion of red with black—scarlet appearing as green, because it is seen as yellow mixed with black—and crimson as blue, because it is seen as red mixed with black.

The author referred, in conclusion, to the observations of Brewster and Dove on the visibility of red to normal eyes, as proving that they became blind to this colour in dim or unfavourable light, much sooner than to blue, not to mention yellow ; so that, in the colour-blind, we only see an exaggerated manifestation of a limitation of vision which belongs to all eyes.

2. On the Romaic Ballads. By Professor Blackie.

The following Donations to the Library were announced :—

The Quarterly Journal of the Geological Society. Vol. X., Part 1. 8vo.—*From the Society.*

Journal of the Statistical Society of London. Vol. XVII., Part 1. 8vo.—*From the Society.*

Journal of the Royal Geographical Society. Vol. XXIV. 8vo.

General Index to the Second Ten Volumes of the Journal of the Royal Geographical Society. 8vo.—*From the Society.*

Proceedings of the Literary and Philosophical Society of Liverpool. 1851–3. No. 7. 8vo.—*From the Society.*

A Collection of Tables, Astronomical, Meteorological, and Magnetical. By Lieut.-Colonel J. T. Boileau. 4to. 5 Copies.—*From the Directors of the Honourable East India Company.*

Mémoires de l'Academie Nationale des Sciences, Belles Lettres, et Arts de Lyon. Classe des Lettres. Tome 1er. 8vo.—*From the Academy.*

Mémoires de l'Académie Nationale des Sciences, Belles Lettres, et Arts de Lyon. Classe des Sciences. Tome 1er. 8vo.—*From the Academy.*

Monday, 3d April 1854.

Dr CHRISTISON, V.P., in the Chair.

The following Communications were read:—

1. On a New Hygrometer, or Dew Point Instrument. By Professor Connell.

This instrument consists essentially of a little spherical bottle of thin brass, polished externally; a small exhausting syringe; a thermometer with ground brass stopper; and a brass clamp. The bottle has a diameter of $1\frac{3}{20}$ inch, and is capable of holding half an ounce. Its neck is attached to the syringe by means of a lateral screw, and is three-fourths of an inch high, and about three-tenths of an inch wide. The syringe is about five inches long, and has a diameter of eight-tenths of an inch. The stopper attached to the thermometer fits air-tight into the upper part of the neck of the bottle. The clamp is intended for securing the instrument to the sill of an open window, or to a table or other fixture in a room. Three drams of ether are then slowly introduced into the little bottle, and the thermometer inserted. The syringe is worked slowly at first, and the speed gradually increased, when the thermometer will immediately begin to fall from the cold produced by the evaporation; and the exhausting process is continued until dew is seen to be deposited on the external surface of the little bottle. The temperature indicated by the thermometer is then noted, the process of exhaustion stopped, and the temperature again noted when the dew disappears from the brass surface. The mean of these two observations may be taken as the dew point. To prevent the spreading of the heat produced by the friction of the piston, to the little bottle, the termination of the syringe which screws into the neck of the bottle is constructed of ivory; and as it is found that the vapour of the ether acts on valves of the usual oiled silk, they are constructed of goldbeater's leaf, four plies of it being used for each valve. A reduction of temperature, varying under different circumstances of temperature from 20° to 40°, has been produced by the instrument; and should it ever be found that extreme cases of united cold and dryness of atmosphere shall occur, which are not within the power of the present size of the instrument, there is little doubt that a sufficient increase of re-

ducing energy may be attained by a moderate increase of the size of the syringe.

The amount of ether consumed in an observation rarely exceeds half a dram, and frequently falls a good deal short of this, the cost thus being from a halfpenny to a farthing. The residual ether may be repeatedly employed, making up its amount each time to three drams from fresh ether. It ought to be kept for use in a separate little bottle. The leather of the piston ought to be occasionally rubbed with olive oil, and the washers of the connecting screws ought not to be allowed to become too dry. The syringe must be of the most approved construction, and all the apertures of the neck of the bottle and of the valve-piece sufficiently wide. Comparative observations have been made regarding the indications of this instrument, of Daniell's hygrometer, and of Dalton's mode of transference of a cold liquid from one vessel to another, which last is usually admitted as a kind of standard of compression. Those of Daniell are usually a very little in excess, and those of this instrument a very little in deficiency; but the deviation of both is on an average within 1° Fahrenheit.

The instrument is constructed by Messrs Kemp of Edinburgh, with the proper accompaniments of measure, bottles for ether, &c., all packed in a little box. It is thought that it will be found to offer advantages in point of considerable security from accidental fracture in travelling.

2. On the Stability of the Instruments of the Royal Observatory. By Professor Piazzi Smyth.

In an observatory where, as in that of the Calton Hill, the principal object of pursuit is the determination of the exact places of the fixed stars, and the investigation of those exceedingly slow secular variations, which require many thousands of years to run their cycle,—the stability of the instruments, as a necessary element to the accuracy of the observations, becomes of the extremest importance.

To secure this quality much invention and no little ingenuity have been employed, but not yet with perfect success; for invariably the more accuracy we demand, the more insuperable difficulties appear to arise. Even nature at last appears to be taxed beyond her powers, for we find when we have passed beyond a certain degree of magnifying power, that there are no bodies absolutely stiff and rigid—none constantly of the same dimensions; but all are expanding and con-

tracting, and giving and limiting with every change of temperature or application of small accidental pressures. All this takes place, it is true, within limits which are perfectly inapplicable to ordinary observation, but are of the utmost importance to be attended to in astronomical inquiries. And so certain is it that changes and distances must exist in some shape and some form in every case, that if any one observer was hardily to declare that his telescopes kept their adjustments perfectly, or had no error, the statement would only be looked on by astronomers as proving that his observations were very rough and inaccurate.

The most prejudicial form in which the effects of instability can manifest themselves, is in any irregular motion of the stands whereon the instruments rests.

This is usually guarded against by constructing these stands in the shape of large and heavy blocks of masonry, the heavier the better. But even when the greatest practicable size has been reached, perfect immunity from disturbing influences is not obtained. This was signally experienced at Greenwich some years ago, when a telescope was firmly built into a large stone pier, with the view of making such very exact observations of a certain star, as to be able to ascertain its annual parallax. But long before the year was elapsed, it was found that the measures were absolutely vitiated, by the irresistible swelling of the hill from rain, and the consequent heaving up of one end of the pier.

Experience therefore drew the rule, that in addition to the utmost security which a large mass can give to the pier, it is proper to introduce some principle of reversal in the instrument placed upon it. For with such a method, the exact state of adjustment of the whole can be ascertained for any instant. Then it will probably be found that the structure, the permanence of whose position could not be depended on for a year, may be relied on from day to day, if not implicitly, at least to within far less than the limits of the probable error of observation.

In the Edinburgh Observatory both these principles have been long since introduced, and have lately been carried further towards perfection.

The stone piers, for instance, which were erected by our respected member Mr Jardine, are models of excellent masonry, composed of peculiarly dense material, in the largest available blocks; and what is more important, they are founded on the hard porphyry rocks of

the hill. Had they been bedded on gravel or clay, or the softer rocks that the English Observatories are generally confined to, they might have been subject to dangerously irregular movements, owing to the infiltration of water in the soil. But twenty years of careful observation here have not detected any effect of this sort, though they have shown, in the piers of the *transit instrument*, the existence of a small annual displacement of their tops, caused apparently by a difference in the expansion from temperature of the two shafts, though they were purposely cut out of the same bed in the quarry. But as this displacement, even at its maximum, reaches only to 0·001 inch, and proceeds very regularly, its effects on the observations may easily be guarded against.

The second principle above alluded to, viz., that of reversal, was not introduced into the Edinburgh transit in a perfectly unexceptionable manner. At the time of its construction it was certainly thought well of. But, with the usual unhappy tendency to run to extremes, men had no sooner discovered that mere weight in the piers, and the telescopes resting on them, was not a guarantee for their perfect stability, and that the reversing was a necessary adjunct— than they began immediately to attend almost solely to this latter feature, and to make the instruments so slight and delicate, as to require constant reversing. Especially vicious, too, was the then plan of making the metal bearings, through the intervention of which the instrument rested on the pier; for they were made so small, and so weak, and of such a complicated construction, that the good qualities of the masonry, such as they were, became neutralized, and very much larger and more uncertain errors were introduced.

From this source arose those various fluctuations in the position of the transit instrument which I had the honour of describing to the Society in 1847. They had been first detected by my predecessor, and were finally traced up theoretically by myself, to the unequal expansion of certain adjusting screws in the Y block. Now these adjustments should never have been there; and was precisely a reason why the Y block could *not* be firm. They were introduced with the vain idea of enabling the astronomer each day to screw up the instrument to perfect truth before he began his observations. But Professor Henderson knew very well, that after a screw is once touched, it does not attain its true bearing for days, and sometimes for weeks; and he knew also that the *quantity* of any error can be measured numerically much more easily than it can be corrected

mechanically. He therefore adopted the very proper plan of leaving the adjusting screws untouched, but of measuring the amount of error each day, and calculating the effect thereof on the observations.

Still the adjustable Y could not be so firm as a plain block; and being at last pretty plainly convicted of producing the bad effects already described, a necessity came for introducing new and firmer bearings. I can now describe the mode in which this was effected, and the astronomical results which have followed. I applied first to the German maker of the instrument, but found him far too fearful of leaving the old beaten paths of instrument-making to attempt any improvement. Next, therefore, I applied to Mr John Adie of this city, and am happy to say that he carried out my designs in a perfectly satisfactory manner, and so caused the Edinburgh transit to be the first in which this signal improvement has been made; for its advantage is now recognised, and has been adopted elsewhere.

The new Ys are now large blocks of cast-iron, of the whole area of the top of the pier, and weighing as many hundredweights as the old Ys did single pounds. They have, moreover, no adjustments; but the notches in which the pivots of the instrument rest were filed, by repeated trials, to within a certain small quantity of the truth, and have since only been subjected to examinations for the quantity of error. The result, now tested by many years, has been highly satisfactory. For, firstly, they have never been so far out as to require a second filing, or to be out of the limits of convenient calculation; and, secondly, what small amount of variation of position they have been found liable to, has been almost entirely the slow and regular expansion of the piers already alluded to. There has been certainly a difference in the amount of wear of either Y; but this has been exceedingly small, and has very regularly increased with the time, while the large anomalous and irregular fluctuations, which were the dangerous features of former years, seem to be effectually removed. Even when labouring under this drawback, the Edinburgh observations, though not all that they might have been, were at least equal in accuracy to those of any other observatory; so that I trust that they will still, through this alteration, be enabled to keep up their comparative character, whatever improvements may have been made elsewhere.

As a specimen of the increased regularity now of the march of the instrument in its annual temperature movement, I subjoin the observed errors of similar periods of the years 1841 and 1851:—

1841.		1851.	
April 21	+ 0·46 sec.	April 21	− 0·04 sec.
„ 23	+ 0·53 „	„ 23	− 0·14 „
„ 27	+ 0·28 „	„ 26	− 0·00 „
„ 29	+ 0·16 „	May 15	− 0·12 „
May 3	+ 0·36 „	„ 22	− 0·17 „
„ 10	+ 0·14 „	June 10	− 0·10 „
„ 21	+ 0·27 „	„ 25	− 0·18 „
„ 28	+ 0·02 „	„ 27	− 0·19 „
June 1	+ 0·05 „		
„ 4	+ 0·27 „		
„ 10	+ 0·46 „		
„ 27	+ 0·30 „		

But in addition to the stability of the instruments of an observatory being affected by the slow movements detailed above, it may be injured by quick vibratory motions, not producing permanent change of place. This is, moreover, precisely the sort of inconvenience generally expected on a rocky foundation. Under such a prejudice too was it, that at the first meeting of the British Association in Edinburgh, several of the members, somewhat too hastily, assumed, from their previous prejudices against rock, that the Calton Hill was by no means suitable for an observatory, and declared that good observations could never be made there. But though this unfounded opinion was refuted publicly almost as soon as published, by Professor Wallace and others, good men of the day, and has since been more formally put to the rout by Professor Henderson's long and excellent series of published observations; yet the cry having once been raised, a lingering echo seems still to exist in some persons' minds, that the Calton Hill, because it is rock, is always in such a state of tremor as to preclude the efficient performance of the instruments. And, worse still, only last summer, on a certain public occasion, one of the very gentlemen who in 1834 showed such want of discretion and judgment, again made a similar exhibition of himself. For putting out of sight the facts of all the thousands of Edinburgh Observations, since printed and published, he stated in a public place, that the British Association had declared that the site of the Edinburgh Observatory was not a proper one for an astronomical establishment, and that no good observations could ever be made there, leaving it of course to be inferred that no proof to the contrary had ever been since advanced, and that the dictum held still; and was that of the Association as a body; which it never was.

With gentlemen who will adhere to a favourite theory of their youth, in spite of all the myriads of facts contained in the volumes since published by the Observatory, I fear that the few additional ones which could be condensed into this paper would make but small impression. Some very peculiar instances, however, can now be brought forward; for there are at present in the neighbourhood far more powerful shaking influences than in those former days, and the existing instrumental means are more sensitive than ever to detect vibrations.

These increased means of shaking are the introduction of railways into the vicinity of the Observatory, and the running along them at high velocities of long and heavy trains, creating a far greater disturbance in the soil than the rumbling of any number of carriages along Waterloo Place.

The improved method of detecting the effect of this disturbance is the recent adaptation of the collimating eyepiece, with modifications allowing of unusually high magnifying power and with good definition, and its employment in combination with a trough of fluid mercury.

Tested in this way, a vibration is undoubtedly perceived at times, and nowhere could we expect to be entirely free; for such a universal cause as the wind striking on the outside of a building would produce some degree of tremor in the subjacent soil. But the question here is, Does the vibration take place to such an extent as to vitiate the observations?

In answer to this I say, Certainly not; for during the last five years, the collimating apparatus has been in weekly, if not in daily, use with the transit instrument, and on no single occasion was there ever any impediment to accuracy of measure caused by vibration transmitted through the ground from any of the neighbouring roads or railroads;—though from the remarkable sensibility of the apparatus employed, the effects of the wind shaking the building, or persons walking about, in, and even immediately around it—circumstances not peculiar to the Calton Hill—have sometimes impeded the observations.

But inasmuch as on each day that the observations were made, they lasted only about twenty minutes, the theoretical shakers may possibly suggest, that chance had always hit on the times of no railway trains being on the move. Recently, therefore, I made a more crucial experiment, and in this manner:—

I stationed myself one day for three hours at the mural circle, to

which a very powerful collimating eyepiece has been applied, and, having the telescope pointed to the mercury trough, and the reflected wires in view, I noted carefully the times and the characters of any defalcations from good definition. Meanwhile the assistant astronomer had gone to the part of the railroad nearest to the Observatory with a chronometer, and noted the times of any trains passing, their speed, and the number of carriages. On his return, the lists of times being compared, it was found that *no* result had attended long trains moving slowly or short ones moving quickly, but that the *long* trains moving *quickly* had produced a barely sensible effect in spoiling somewhat of the definition of the reflected wires. Never had this disturbance, however, amounted to a quantity that need have prevented an observation being taken. In a word, the disturbance was practically quite unimportant, and this, with an apparatus so sensitive that a slight tapping with the hand on the great stone-pier, containing about 120 cubic feet, produced so great an effect as to render the wires for a time altogether invisible.

Moreover, by comparing the amount of railway vibration observed here, with that found at Greenwich and other observatories on loose and soft soils, we find it to be less than a third of what is experienced there. This result, so contrary to the usual belief of the facility with which rock conducts vibration, is perhaps attributable to the circumstance, that whatever vibration is produced in the hard, unyielding material, is very small, while that in the softer, looser soil, is very great and violent at the place. In the rock, the wave, such as it is, may travel quicker and farther, and with the characteristics of a high musical note, than one of the same initial size in gravel; but the wave produced in the gravel by the same disturbing cause appears to be so much larger at the place, as to be able to travel to a very great distance, though with a slower motion and a lower note (if any be audible) than in rock, and to be felt to a greater extent within a certain range.

The whole result is thus highly satisfactory for the stability of the Edinburgh instruments; since we have not only, by reason of this rock foundation, an immunity from the prejudicial action of water penetrating the ground and heaving up the piers, but there is also such a decided lessening in the amount of vibration, and the disturbance of any optical image seen in the mercury.

3. On a General Method of effecting the substitution of

Iodine for Hydrogen in Organic Compounds, and on the properties of Iodo-Pyromeconic Acid. By Mr James Brown, assistant to Dr Thomas Anderson.

Following up his researches on pyromeconic acid, read before this Society in 1852, the author described a method which he had recently discovered, through his experiments on iodo-pyromeconic acid, of generally obtaining iodine substitution for hydrogen compounds.

The mere digesting pyromeconic acid with tincture of iodine was not successful; because, as the author considered, there was no body present, capable of drawing all the hydrogen in the compound to itself, and so leaving, as it were, an open space which the iodine might step into and occupy.

This requisition, however, he found to be perfectly complied with, by introducing with the iodine a certain quantity of either bromine or chlorine; and the mode which he preferred of producing the iodo-pyromeconic acid was, by mixing a freshly-prepared solution of chloride of iodine with a cold saturated solution of pyromeconic acid.

The resulting acid is monobasic, and forms salts, of which those of baryta of lead were described by the author at length.

The following Gentleman was elected an Ordinary Fellow:—

HENRY Dunlop, Esq. of Craigton.

The following Donations to the Library were announced:—

Smithsonian Contributions to Knowledge. Vol. V. 4to.

Sixth Annual Report of the Board of Regents of the Smithsonian Institution for the year 1851. 8vo.

Smithsonian Institution Meteorological Tables. Prepared by Arnold Guyot. 8vo.

Portraits of North American Indians. With Sketches of Scenery, &c. Painted by J. M. Stanley. Deposited with the Smithsonian Institution. 8vo.

Catalogue of North American Reptiles in the Museum of the Smithsonian Institution. 8vo.—*From the Institution.*

Owen's Geological Survey of Wisconsin, Iowa, and Minnesota. With Illustrations. 4to.

Schoolcraft's History of the Indian Tribes of the United States. Part 3. 4to.

Memoirs and Maps of California. By Ringgold. 8vo.

Stansbury's Expedition to the Great Salt Lake. 8vo. With Maps.

Report on the Geology of the Lake Superior Land District. By J. W. Foster and J. D. Whitney. Part 2. 8vo. With Maps.

Official Report of the United States Expedition to explore the Dead Sea and the River Jordan. By Lieut. W. F. Lynch, U.S.N. 4to.—*From the American Government.*

Boston Journal of Natural History, containing Papers and Communications read before the Boston Society of Natural History. Vol. VI., Nos. 1 & 2. 8vo.—*From the Editors.*

Bulletin de la Société Imperiale des Naturalistes de Moscou. 1851, Nos. 3 & 4. 1852, No. 1. 8vo.—*From the Society.*

Bulletin de la Société de Géographie. 4ieme Série. Tomes IV. & V. 8vo.—*From the Society.*

Jahrbuch der Kaiserlich-Königlichen Geologischen Reichsanstalt. 1852, iii. Jahrgang. 1853, iv. Jahrgang. 8vo.—*From the Institute.*

Flora Batava. 173 Aflevering. 4to.—*From the King of Holland.*

Stellarum Fixarum imprimis duplicium et multiplicium positiones mediæ pro epocha 1830,0. Auctore F. G. W. Struve. Fol. —*From the Russian Government.*

Mémoire sur les Ouragans de la Mer des Indes, au sud de l'Equateur. Par M. A. Lefebre. 8vo.

Considérations générales sur l'Océan Pacifique pour faire suite à celles sur l'Océan Atlantique et sur l'Océan Indien. Par M. Charles P. de Kerhallet. 8vo.

Tableau général des Phares et Fanaux des Cotes de la Méditerranée, de la Mer Noire, et de la Mer d'Azof. 8vo.—*From the Depôt Général de la Marine.*

Abhandlungen der Mathemat. Physikalischen Classe der Koeniglich Bayerischen Akademie der Wissenschaften. Bd. VII., 1th Abth. 4to.—*From the Academy.*

Annalen der Königlichen Sternwarte bei München. V. Bd. 8vo.

Jahres Bericht der Münchener Sternwarte für 1852. 8vo.—*From the Observatory.*

Afrika vor den Entdeekungen der Portugiesen. Von Dr Friedrick Kuntsmann. 4to.—*From the Author.*

Studien des Göttingischen Vereins Bergmännischer Freunde. Im namen desselben herausgegeben von J. F. L. Hausmann. Bd. XVI. Heft. 1 & 2. 8vo.

Nachrichten von der Georg-Augusts Universität und der Königl. Gesellschaft der Wissenschaften zu Göttingen. 1852. 12mo. —*From the Society.*

Monday, 17*th April* 1854.

RIGHT REV. BISHOP TERROT, Vice-President, in the Chair.

The following Communications were read:—

1. On the Products of Destructive Distillation of Animal Substances. Part. III. By Dr Thomas Anderson.

2. Notice of the Completion of the Time-Ball Apparatus. By Professor C. Piazzi Smyth.

The electric time-ball, erected on the Calton Hill last October by the Government, and placed under the author's charge, has now been at work for five months. But the work has necessarily been of an experimental or tentative character; for before the accuracy of the signals could be guaranteed, it was necessary to have experience of the machinery in all weathers; and, moreover, the present strength of the Observatory establishment, and the nature of pre-existing occupations, prevented the experiments being made every day.

There have, however, been now upwards of 100 daily signals made, *four* only of which have proved defective, and from causes which have since been remedied, so that there is now strong warrant against future accidents.

In the course of the trial, the following questions presented themselves, and, if not answered satisfactorily by the experiments, suitable alterations were made in the machinery.

1*st*, Is the fall of the ball *equally* quick in windy as in calm weather?

The answer is, that it is so, owing to the great weight of the ball, something near a ton, overpowering any side pressure of the wind, while all other friction is carefully relieved.

2d, Is it sufficiently quick to make the commencement of the fall an accurate observation ?

It is ; for it falls through the first 4 feet in less than 0·3 of a second ; and as a separation of the descending ball from the fixed cross staffs to the extent of 6 inches would be abundantly visible to observers all over the city, they should not err to more than one second.

3d, Is the impetus of this falling body sufficiently broken and quieted in fall, so as not to endanger the permanence of itself or the building ?

The concussion is so completely broken by the cylinder of air which receives and bears up the piston connected with the ball, that the ball invariably comes to rest on its bed block without any sensible shock or sound.

4th, Is the dropping of so huge and cumbrous a weight as the ton-heavy ball managed by a trigger sufficiently delicate to insure exactness of manipulation, and sufficiently certain, as not to be thrown out by accidental causes ?

This is the case to an eminent degree, through the introduction of a small auxiliary ball to do the labour of dropping the big one, so that it is only the trigger of the small one that has to be pulled by hand or by the electric force, and it has to be pulled with a force of but a few grains, and through about $\frac{1}{30}$th of an inch.

Excepting the variations of strength of a certain spring, depending apparently on temperature, and now compensated by adding weights each morning, no other inconvenience has been experienced. And the trigger has held its place firmly, even when during some of the violent gales in the winter, the top of the monument was rocking about to such an extent as to make the duty of attending to the ball somewhat unenviable.

5th, Is there any loss of time or accuracy by the ball being on Nelson's Monument, and not in the Observatory ?

Practically, none ; for the trigger is pulled, and the ball dropped by electro-magnets, which are instantaneously animated by the galvanic circuit being completed in the Observatory.

6th, Is there any guarantee or permanent record of the time at which the signal was, and must have been made ?

There was not, as the ball was placed in my hands, for all the exactness depended on the skill of the person making the signal ;

and, after it was made, nothing was left behind to shew when it was made. This has, however, lately been altered, and the circuit is now completed by a mean-time clock, which is compared every day with the transit clock, and adjusted to the true time; their comparisons being duly entered in a ledger on every occasion, shew incontestibly the limit of error of the clock, and thereby of the fall of the *ball each* day.

Referring to these entries, I find that, during the last fortnight, the correction of the clock at a quarter before one, were, on

April 3,	− 0·0	April 11,	+ 0·1
... 4,	− 0·1	... 12,	− 0·0
... 5,	− 0·0	... 13,	+ 0·2
... 6,	+ 0·1	... 14,	− 0·1
... 7,	+ 0·2	.. 15,	− 0·1
... 8,	− 0·1	... 17,	− 0·1
... 10,	− 0·0		

And as the greatest daily rate of the clock during this period was never more than 0·3 seconds, the above must have been sensibly the errors of the clock at one hour, and, therefore, of the drop of the ball, subject only to a constant correction for the time necessary for the electricity to pull the various triggers. I have not been able yet to observe this quantity in any but an indirect manner, but suspect that it is under 0·1 second.

7th, What is the accuracy of the approximate signals afforded by the half rise and the full rise of the ball at 5 minutes and at 2 minutes respectively before 1?

As the clock is also made to give a species of electric signal to the raiser of the ball, he may and should have the windlass in motion within 0·5 of a second of the even minute. But, inasmuch as the movement of the ball on the mast is very slow, by reason of the number of intervening wheels and pinions necessary to get up the requisite power, the ball will not be seen to move visibly to persons outside, until the crank has made several revolutions.

From a series of four months' excellent observations of the time ball by Sir T. Brisbane, it appears that, to him in St Andrew Square, the rises were seen on an average 2·5 seconds too late, with a probable error of about 3 seconds. While, from another series of two months' observations by Mr Swan, at a greater distance from the hill, as in Duke Street, the retardation, as might be expected,

was greater, or about 3·5, while the probable error was about the same. By using a telescope with a cross view, as he appears to have done lately, he has considerably reduced both quantities. But each person should determine the amount of retardation for himself, as depending upon his distance from the hill, peculiarity of observation, and other such causes. This done, and the quantity applied to one of the rises as a correction, will give a very near approximation to the error of the observer's watch, so that he will be fully prepared to observe the instant of the *drop* to the utmost exactness.

8. Has the accuracy of the drop of the ball been independently tested?

As to absolute time, not that I am aware of; but as to relative time, it has by the two very careful series of observations already mentioned, by Sir T. M. Brisbane and Mr Swan. The results of these are given below in the rates of their chronometers, for similar days. And it will be observed, that although one of them did alter its rate somewhat irregularly backwards and forwards, still as the other was going on in a uniform march at the selfsame time, the anomalous effect was all owing to the one chronometer, and nothing sensible was due to any error of the time-ball.

In conclusion, the author observed that the arrangements which were in the course of being made, would give uninterrupted facility to the public for ascending to the top of the monument.

3. On a Black Tertiary Deposit, containing the Exuviæ of Diatomes, from Glen Shira. By Dr Gregory.

4. Additional Note to a Paper on the Structure of Coal, and the Torbanehill Mineral. By Dr Bennett.

5. On the Mechanical Energies of the Solar System. By Professor William Thomson.

In this paper it is shown, that by the sun's heat there is an emission of mechanical energy from the solar system, amounting in about 100 years to as much as the whole energy of the motions of all the planets. The principal object of the paper is to investigate the source from which this vast development of energy is drawn. It is argued, that either a store of primitive heat must be drawn upon,

or heat must be generated by chemical action (combustion), or heat must be generated by other forces than those of chemical action, that is, by forces of moving masses. Any store of primitive heat that can be drawn upon in solar radiation, must be entirely within the sun. It is shown that such a store would *almost certainly* be insufficient for the supply of the heat which has *certainly* been emitted during 6000 years, and it is also shown with about equally strong probability, that chemical action among elements of the sun's mass, would be insufficient to supply the actual emission for any such period of time. It is concluded that the source drawn upon in solar radiation cannot be primitive heat, nor heat of intrinsic combustion. If not heat of combustion at all, it must clearly be heat derived from the motion of bodies coming to the sun (the utter insufficiency, in point of duration, of ordinary motions of matter within the sun, being quite obvious); or if it be heat of combustion, fuel must be supplied from without. But no matter can come to the sun from external space, without generating, from its motion alone, thousands of times as much heat as it could possibly give rise to either by combustion among elements of its own, or by combination with substances primitively in the sun, unless it were possessed of incomparably greater chemical affinities than any known terrestrial or meteoric substance. It is inferred that the source of solar heat must be meteoric, and is *the motion of meteors coming to the sun.* The idea that solar heat is so produced, appears to have been first published by Mr Waterston, who brought it forward at the late meeting of the British Association at Hull.

But if (as was assumed by Mr Waterston) enough of meteors to generate heat at the actual rate of solar radiation, were falling in from extra-planetary space, the earth in crossing their path, would be struck much more copiously by meteors than there is any probability it is; and the increase of matter round the centre of the system, would within the last two or three thousand years, have caused an acceleration of the earth's motion, which history disproves. Hence the meteors which supply the sun with heat must, at least during historical periods, have been within the earth's orbit. We see them there in the sunshine (when the sun himself is below our horizon) a tornado of dust, called "the Zodiacal Light" whirling round the sun and carrying the inter-planetary atmosphere with them, probably to such an extent, as to cause centrifugal force

enough very nearly to balance solar gravitation upon it everywhere, except close to the sun's surface. The meteors themselves probably evaporate somewhere near the sun, merely on account of the high temperature of that part of space, but ultimately losing their rotatory motion by intense resistance in entering the sun's atmosphere, become condensed into a liquid state by solar gravitation, and come to rest in the sun. The quantity of heat thus generated in the region of intense resistance, by any quantity of matter falling in, will exceed half the equivalent of the work done by solar gravitation on an equal mass moving from an infinite distance by (what must probably be quite insensible in comparison) the latent heat evolved in condensation, together with the heat of any chemical combination that may take place. The other half of the work done by solar gravitation on every meteor which has come from an infinite distance (or from many times the sun's radius off), goes to generate heat in inter-planetary air by friction.

The meteoric matter thus added to the sun, to generate heat at the present rate of emission as determined by Pouillet, if settling at the surface with the same as his mean density, would cover it about sixty feet thick in a year, and would not increase his apparent dimensions by more than about 1″ in 40,000 years; or in 2,000,000 years, by as much as he appears to grow from July to December. It must, therefore (whatever be the actual density of the deposit), be insensible from the earliest historical period of observation till the present time; and for thousands of years to come, if continued only at the same rate, it must remain neither demonstrated nor disproved by the most accurate measurements of the sun's apparent magnitude.

The approximate equality of solar heat in all regions of his surface is probably due to the distillation of the meteors, which if solid when entering the region of intense resistance, would probably give an immensely more copious supply in the equatorial than in the polar regions. The dark spots are probably whirlwinds, analogous to the hurricanes in the tropical regions of the earth's atmosphere, (although produced by a different cause,*) which by centrifugal

* The friction of the vortices of meteoric vapour close round the sun, upon the atmosphere between them, and his surface revolving at the comparatively slow rate of once in twenty-five days, probably gives rise to eddies sometimes

force diminish very much for a time the deposit of meteoric matter on limited portions of the sun's surface, and allow them to cool by radiation so much, as to become comparatively black.

The following Gentlemen were elected as Ordinary Fellows:—

1. Dr William Bird Herapath.
2. Robert Harkness, Esq., Professor of Mineralogy and Geology, Queen's College, Cork.
3. Dr Thomas A. Wise, H.E.I.C.S.

Monday, 1*st May* 1854.

Right Rev. BISHOP TERROT, V.P., in the Chair.

The following Communications were read:—

1. Further Researches on the Crystalline Constituents of Opium. By Dr Thomas Anderson.

2. On the Action of the Halogen Compounds of Ethyl and Amyl on some Vegetable Alkaloids. By Mr Henry How, Assistant to Professor Anderson of Glasgow.

This paper contains some details of a continued investigation, of which the first results were communicated to the Chemical Society of London last year.* It was then shown that new bases are produced by the action of iodide of methyl and of ethyl upon morphia and codeine, which are closely analogous with the ammonium bases of Hofmann, so that these alkaloids should rank among nitryle bases. The fact was also pointed out, that although one of the new salts produced had precisely the centesimal composition of the corresponding compound of codeine, the base of the artificial product was widely different from this alkaloid; and the conclusion was drawn that the primary molecules of these natural formations are of so peculiar a constitution, that chemists are not yet in the possession of means of imitating the process of their construction; for even the attempt

reaching down to the sun's surface, and constituting hurricanes, which would probably have a progressive motion northwards on one side, and southwards on the other side of his equator.

* Quart. Jour. Chem. Soc., vol. vi.

to convert morphia into codeine fails, though the addition of the requisite amount of carbon and hydrogen to the former is readily effected. It was further remarked that the circumstance of both these alkaloids furnishing the same results, under the given circumstances, possibly arose from their similar origin; and that it was intended to examine other alkaloids of opium, and some from other sources, in the same way. In the present memoir it is shown that attempts to produce ammonium bases from other alkaloids of opium have not been successful; but this result has been obtained from strychnine, and the new products have admitted of more detailed examination, from their possessing a more stable nature than the analogous derivatives from morphia and codeine.

Behaviour of Papaverine with Iodide of Ethyl.

Hydriodate of Papaverine.—The next base from opium submitted to trial was papaverine, an alkaloid of well-marked characters, and the subject of some recent researches of Dr T. Anderson.* It was found that, by heating some of this substance in a sealed tube with spirit of wine and iodide of ethyl, it is converted into an hydriodate with great ease. The salt proved to be that of the unchanged alkaloid, of the formula,

$$C_{40}\,H_{21}\,NO_{8},\,HI.$$

It is extremely soluble in water, and the moment the heat is withdrawn from a strong solution, the fluid becomes milky, and an oil is deposited, which assumes a crystalline solid form in the course of a few hours. It is unaltered in the air, but decomposed, at least partially, at 212° Fahr.

All doubt as to the nature of the base in this salt was removed by its analysis when set free, by the action of ammonia on the hydriodate. The white crystalline deposit so obtained, gave, after one crystallization from dilute spirit, analytical results perfectly in accordance with the formula,

$$C_{40}\,H_{21}\,NO_{8};$$

which is that of papaverine. Its reactions were also identical with those characteristic of the alkaloid.

Narcotine and Iodide of Ethyl.

Hydriodate of Narcotine.—This opium base behaved exactly like

* Trans. Roy. Soc. Edin., vol. xxi., part i.

the preceding; the hydriodate of narcotine resulting from the action was an oily substance of a brownish colour, which could not be made to crystallize; it was soluble in hot water, and ammonia threw down from this solution a precipitate easily recognised as narcotine; its nature was fully substantiated by the quantitative analysis of its platinum compound, which gave results agreeing with the salt of narcotine, whose formula is this,

$$C_{46} H_{25} NO_{14} H Cl, Pt Cl_2.$$

The result of this experiment calls to mind a preliminary notice of Wertheim,* in which he announced his detection in opium of two new species of "narcotine," which he terms methylo and propylo-narcotine, while the ordinary alkaloid he regards as ethylo-narcotine. The proof of the existence of this series is desirable, because the ordinary alkaloid, the material of the above experiment, would then seem to be a compound ammonium, and stand a solitary instance of such a substance, unless papaverine be of the same nature. The details of Wertheim's researches have not appeared, but the subject is worthy of being made clear, as there is nothing in the characters of papaverine and narcotine to distinguish them from other alkaloids as a class of bodies.

Cotarnine and Iodide of Ethyl.

Hydriodate of Cotarnine.—This base, a derivative from narcotine by oxidation, behaved quite like its parent under the same circumstances. The hydriodate of cotarnine is a red-brown oil, very soluble in hot, insoluble in cold, water; the nature of its base was ascertained by the formation of its platinum salt, which was a pale yellow substance, and gave numbers on analysis in accordance with the true salt of cotarnine,

$$C_{26} H_{13} NO_6 H Cl, Pt Cl_2.$$

The formation of these hydriodates in the presence of water is possibly brought about by the change of iodide of ethyl and water into hydriodic acid and ether, observed by Frankland† to take place at 300° Fahr.; the presence of bases may determine the change at a much lower temperature.

Where water is absent, it is not easy to see how they are formed,

* Chem. Gazette, 1852, p. 36. † Gerhardt. Suite de Berzelius, ii., 323.

unless ether be produced at the same time from the alcohol used as a solvent; for instance with papaverine, thus—

$$C_{40}H_{21}NO_8 + C_4H_6O_2 + C_4H_5I = C_{40}H_{21}NO_8, HI + 2C_4H_5O.$$

On Strychnine.

This alkaloid, as being one of those which contain two atoms of nitrogen, was considered an interesting object for examination. Numerous speculations have been gone into as to the mode in which this element exists in such substances, before the experiments of Hofmann gave a point of comparison between ammonia and other basic bodies. These are now regarded, viewed from the volatile type upwards, as nitrogen attached to basic hydrogen alone, or to it with hydrocarbons, or finally to hydrocarbons alone, occupying all its place. In the fixed vegetable alkaloids oxygen is included in the system, and here oxygenized hydrocarbons must act as hydrogen, if, as has been attempted to be shown in a former paper on this subject, these bodies are comparable with nitryle bases. In the case of one of these containing two atoms of nitrogen, it is possible that this element performs, as it were, two parts; one being referable to its function in any simple nitrogenous base, while the other may be more analogous to its property when combined with oxygen as NO_4, of replacing hydrogen in the carbohydrogen of the molecule—a speculative suggestion thrown out some few years ago by Fresenius.

This question it is attempted to decide by means of two classes of reagents; the amount of basic hydrogen in strychnine should be ascertained by the action of iodide of ethyl, &c., while any oxidized compound of nitrogen, as NO_4, should be reduced by sulphuretted hydrogen, and hydrogen added while oxygen is removed.

The former part of the subject is gone into in some detail in this paper, while mention is made that strychnine undergoes a curious change with sulphide of ammonium, resulting in the production of hyposulphite of the base, a stable and beautiful salt, and some other product as yet imperfectly studied; from what is at present known, however, it is thought that the change is not of the nature above spoken of.

Action of Iodide of Ethyl on Strychnine.

Hydriodate of Ethylostrychnine.—Strychnine in fine powder is readily attacked by iodide of ethyl, even partially in boiling water;

the insolubility of the base in this menstruum renders spirit a better medium, and the best method of bringing about the reaction was found to be by operations in sealed tubes. At the temperature of 212° Fahr. the change is effected in twenty minutes, and this is announced by the complete solubility of the crystalline contents of the tube in boiling water. The new salt proved to have the formula of hydriodate of strychnine, in which an atom of hydrogen of the base is replaced by ethyl, or in which an atom of ethyl is attached to it considered as an iodide, formed thus :—

$$\underbrace{C_{42}H_{22}N_2O_4}_{\text{Strychnine.}} + C_4H_5I = \underbrace{C_{42}\left\{\begin{matrix}H_{21}\\C_4H_5\end{matrix}\right\}N_2O_4, HI = C_{46}H_{27}N_2O_4, I.}_{\text{New Salt.}}$$

It is soluble in about 50 or 60 parts boiling water, and in about 170 parts at 60°; and is deposited from tolerably dilute fluids in fine, white, four-sided prisms; it is unaltered in the air, and at 212°.

It yields no base to potass or ammonia, but is precipitated unchanged from its aqueous solution in the cold by the former, more immediately in the heat by the latter. Oxide of silver readily eliminates its iodine, and leaves the base in solution, from which it may be obtained in the crystalline state as a hydrate. These reactions assimilate the salt to an iodide, and the salts of the base are accordingly named in accordance, but the conventional nomenclature of the base is not altered. Some of these salts are described and their analysis is given in some cases; they are spoken of as being beautiful substances, and easily obtained pure.

Nitrate of Ethylostrychnine.—This is a compound of such sparing solubility in cold water, that it has served as a test for the base. From dilute hot aqueous solutions it is deposited in colourless refractive prisms of great beauty, which are anhydrous, and have the formula,

$$C_{46}H_{26}N_2O_4, HO, NO_5 = C_{46}H_{27}N_2O_4, NO_6.$$

Chromates of Ethylostrychnine.—A neutral and an acid salt exist, both of difficult solubility in cold water, and of a yellow colour; the former is deposited even from dilute fluids in short prismatic crystals, and the latter as tufts of silky needles.

Bichromate of Ethylostrychnine.—From strong solutions this salt

is deposited in splendid transparent plates, of a golden yellow colour; it has the composition, when dried at 212° F.,

$$C_{46} H_{26} N_2 O_4 HO Cr O_3, HO Cr O_3 = C_{46} H_{27} N_2 O_4 Cr O_4, H Cr O_4,$$

and is thus seen to differ from the peculiar combinations of potass and ammonia, by containing an atom of water more than these salts have. This anomaly may be explained away by the assumption that this atom is retained from the water of crystallization, of which the new salt contains in addition two atoms; its formula being, air dry,

$$C_{46} H_{27} N_2 O_4 Cr O_4, H Cr O_4 + 2 \text{ aq}.$$

Platinum Salt of Ethylostrychnine.—This compound falls at first as a curdy yellow precipitate, which becomes crystalline on standing; from dilute fluids it crystallizes at once in a very beautiful form, viz., in stellate groups of fern-frond-like crystals: it is anhydrous, and has the formula,

$$C_{46} H_{27} N_2 O_4 Cl, Pt Cl_2.$$

The corresponding gold salt crystallizes from water in colourless brilliant prisms, of splendid appearance.

The chloride is a very soluble salt, crystallizing in needles; the sulphate and oxalate crystallize from acid solutions in pearly needles; the acetate is an amorphous gum in the dry state. The chloride gives a crystalline double salt with mercuric chloride.

Carbonates of Ethylostrychnine.—The tendency of the base in aqueous solution to absorb carbonic acid being observed, the attempt to procure carbonates was made, and there exist two; but the monocarbonate cannot be obtained dry, as in the process of evaporation it decomposes into some basic product and impure bicarbonate—a salt which may be produced not only of constant composition, but as a beautiful crystalline substance.

The monocarbonate is readily produced by double decomposition between the iodide of ethylostrychnine and moist carbonate of silver. A few minutes contact suffices to effect the change, the solution of the carbonate is found to decompose on simple evaporation either *in vacuo* or at 212°, into impure bicarbonate, and a substance, insoluble in water, which has the characters of a base, quite distinct from strychnine or ethylostrychnine; but material was wanting to establish its nature thoroughly.

Bicarbonate of Ethylostrychnine.—This salt is formed by passing a stream of carbonic acid gas into a freshly prepared solution of the

simple carbonate: it admits of preparation in the dry state, either at 212°, or *in vacuo;* its solution undergoing in a very slight degree the decomposition just mentioned. Prepared by these means it is a crystalline mass, which is completely soluble in alcohol, and is thrown down in very fine prismatic crystals, by ether added in small quantity to this solution. It is not deliquescent, but is very soluble in cold water; its reaction is strongly alkaline. Its composition is shown by analysis to be, as expressed in the formula,

$$C_{46}\,H_{26}\,N_2\,O_4\,HO\,CO_2,\,HO\,CO_2 = C_{47}\,H_{27}\,N_2\,O_4\,CO_3,\,H\,CO_3$$

quite analogous to the corresponding salt of potass.

In repeating some experiments mentioned in Liebig's Traité,* it was found that the statement there made as to the existence of a solid carbonate of strychnine is erroneous; nor could carbonates of morphia, codeine, papaverine, or narcotine be obtained.

The notice of Langlois† having succeeded in forming carbonate of quinine arrested the intended extension of these trials with other alkaloids.

Hydrate of Ethylostrychnine.—When moist oxide of silver is added to the solid iodide, a strongly alkaline fluid of a rich purple colour is obtained which yields on evaporation *in vacuo* a crystalline residue, containing some little carbonic acid. This is completely soluble in absolute alcohol, and ether added to the fluid with certain precautions, occasions the deposition of a substance in beautiful small colourless needles, which prove on analysis to be the hydrated ethylostrychnine, or oxide of ethylostrychnium, of the formula,

$$C_{46}\,H_{27}\,N_2\,O_4\,O,\,HO + 3\,aq.;$$

it differs from its assumed analogue, the crystallized hydrate of potass, in containing an atom less of water.

The substance cannot be freed of its water by heat, as its aqueous solution is found, by evaporation at 212°, to undergo the same change as the monocarbonate, and also to absorb carbonic acid to some extent. It is not deliquescent, its aqueous solution has a red purple colour, and an extremely bitter taste; it precipitates barium and calcium solutions partially in the heat, and the heavy metallic oxides at once from their salts. It yields products by the action of chlorine,

* Liebig. Traité de Chimie Organique, par Gerhardt, ii. p. 630.
† Chem. Gazette, 1853, p. 470.

iodine, and bromine. By treatment with sulphide of hydrogen it and its carbonate are converted into hyposulphite of some sort, which may be crystallized from alcohol. It gives the same reaction with bichromate of potass and sulphuric acid as strychnine.

When iodide of ethylostrychnine is distilled with soda-lime, a non-basic oil, and a base insoluble in water, are obtained, but material was wanting to prove whether the latter is leucoline or ethyloleucoline. The solution of the hydrate itself evolves the odour of a volatile base on ebullition.

Action of Iodide of Ethyl on Ethylostrychnine.

When a solution of the hydrate in absolute alcohol is heated with iodide of ethyl in a sealed tube, iodide of ethylostrychnine is reproduced, accompanied by some secondary product, which appears to modify its characters to some degree.

Action of Chloride of Amyl on Strychnine.

Chloride of Amylostrychnine.—By protracted boiling of the alkaloid with absolute alcohol and chloride of amyl in a sealed tube it was completely changed. The new salt was obtained by distilling off the excess of spirit and reagent as a crystalline mass, which was completely and readily soluble in warm water. In the crystals from water, the salt was found to have the composition expressed in the formula,—

$$C_{52}\,H_{33}\,N_2\,O_4\,Cl,\,HO\,+\,7\,aq.$$

At a temperature of 212° Fahr, the 7 aq. are expelled, and the dried compound is—

$$C_{52}\,H_{33}\,N_2\,O_4\,Cl,\,HO.$$

Its characters are generally analogous to the corresponding salt of the ethyl base. It is of greater solubility in water and in spirit. Its decomposition by heat is attended by the final production of fumes of a most disgusting odour.

In contact with ammonia, it appears to undergo some decomposition; in the cold, long contact produces a crystalline substance, having the qualitative characters of strychnine; the reproduction of this alkaloid, and the formation of amylamine, appears possible under the circumstances, as in the equation,

$$C_{52}\,H_{33}\,N_2\,O_4\,Cl + NH_3 = C_{42}\,H_{22}\,N_2\,O_4 + C_{10}\,H_{13}\,N,\,HCl;$$

but the proof of this decomposition was not attained, as much of the original salt remained unchanged.

With strong ammonia in a heated sealed tube, a more complex change appears to take place; but its nature was also not made out.

Chloride of ethylostrychnine also yields a small crystalline deposit when left in contact with ammonia for some days.

Nitrate of Amylostrychnine.—This is a beautiful salt, crystallizing from water in groups of colourless prisms, which have the composition,

$$C_{52}\,H_{33}\,N_2\,O_4\,NO_6,\,HO,\,+\,10\text{ aq.};$$

the salt is not obtained anhydrous at 212°, but when so dried, is

$$C_{52}\,H_{33}\,N_2\,O_4\,NO_6,\,HO;$$

it furnishes a crystalline double salt with mercurous nitrate.

Bichromate of Amylostrychnine.—This is a yellow crystalline salt, difficultly soluble in cold water; when dried at 212°, it is found to have the composition,

$$C_{52}\,H_{33}\,N_2\,O_4\,CrO_4,\,H\,Cr\,O_4,$$

analogous to the corresponding compound of the ethyl base.

Chloride of amylostrychnine, when treated with oxide of silver, yields an alkaline purple solution, which agrees in properties with solution of ethylostrychnine, and leaves, on evaporation *in vacuo*, a crystalline residue, whose characters are so like that left by the other that there can be little doubt the crystals obtained by use of alcohol and ether are the hydrate of amylostrychnine, having a composition closely corresponding with the ethyl product.

It is hoped to clear up, in a future paper, some of the points touched upon in the present, and the following inferences are drawn from the facts brought forward:—

That the new basic compounds, ethylo and amylo strychnine, are analogous to Hofmann's ammonium bases, and quite distinct from the natural alkaloids.

That the already complex molecule of the vegetable alkaloid is rendered more susceptible of change by association with additional hydrocarbons.

That strychnine appears to be made up of a complicated molecule in which the one atom of nitrogen, as in ammonia, is associated with a nitrogenous aggregate of elements, whose function is that of three atoms of hydrogen, and whose nitrogen is in some distinct form of

combination, as yet undetermined, from that of the first, generic atom,—a composition attempted to be expressed thus:—

$$C_{42}H_{22}N_2O_4 = \left\{ C_{42}H_{22}NO_4 = \left.\begin{matrix} H \\ H \\ H \end{matrix}\right\} N \right\}$$

And the appropriation of an alcohol hydrocarbon by this molecule causes the production of an ammonium congener, which, in combination with some electro-negative element, may be thus written:—

$$C_{42}H_{22}NO_4 = \left.\begin{matrix} \left\{\begin{matrix} H \\ H \\ H \end{matrix}\right. \\ C_n H_{(n+1)} \end{matrix}\right\} N + X.$$

In conclusion, a tabular statement is made of the products analysed in course of the investigation, with the termination *ium* for the bases, in analogy with ammonium:—

Hydriodate of papaverine		$C_{40}H_{21}NO_8HI$
Iodide of ethylo-strychnium		$C_{46}H_{27}N_2O_4I$
Hydrated oxide of	do. crystallized	$C_{46}H_{27}N_2O_4O, HO, + 3$ aq.
Nitrate of	do. ...	$C_{46}H_{27}N_2O_4NO_6$
Bichromate	do. dried at 212°	$C_{46}H_{27}N_2O_4CrO_4, HCrO_4$
Do.	do. crystallized	$C_{46}H_{27}N_2O_4CrO_4, HCrO_4 + 2$ aq.
Platinum salt	do. ...	$C_{46}H_{27}N_2O_4Cl, PtCl_2$
Bicarbonate do.	do. dry	$C_{46}H_{27}N_2O_4CO_3, HCO_3$

Chloride of amylo-strychnium	dried at 212°	$C_{52}H_{33}N_2O_4Cl, HO$
Do.	do. crystallized	$C_{52}H_{33}N_2O_4Cl, HO + 7$ aq.
Nitrate of oxide	do. dried at 212°	$C_{52}H_{33}N_2O_4NO_6, HO$
Do.	do. crystallized	$C_{52}H_{33}N_2O_4NO_6, HO + 10$ aq.
Bichromate	do. dried at 212°	$C_{52}H_{33}N_2O_4CrO_4, HCrO_4$.

3. On the Mechanical Value of a Cubic Mile of Sunlight, and on the possible density of the Luminiferous Medium. By Professor William Thomson.

The velocity of light being 192,000 miles per second, and the mechanical value of sunlight incident perpendicularly on a square

mile at the earth's distance being $83 \times 5280 \times 5280$ foot pounds; the mechanical value of all the energy potential and actual, kept up in the space of a cubic mile by sunlight crossing it, is $\dfrac{83 \times 5280 \times 5280}{192,000}$ $=1200$ ft. lbs. at the earth's distance. Similarly the mechanical value of a cubic mile of sunlight near the sun is found to be $1200 \times 46,000 = 55,000,000$ foot pounds.

If A be the excursion on each side of its position of equilibrium, which any particle would have if the mean effect of the solar radiation at the earth's distance were produced by plane polarised vibrations of wave length λ, the mass of a cubic foot of the luminiferous medium, in pounds, is shown to be

$$\frac{g \times 83}{2\pi^2 \times V^3}\left(\frac{\lambda}{A}\right)^2 = \frac{\left(\dfrac{\lambda}{A}\right)^2}{77 \times 10^{23}}$$

where g is the number $32 \cdot 2$, measuring the force of gravity, and V the velocity of light in feet per second. Similarly, if A and λ relate to sunlight near the sun, the mass of a cubic foot of the vibrating medium in that locality is found to be

$$\frac{\left(\dfrac{\lambda}{A}\right)^2}{166 \times 10^{18}}$$

The possibility of great variation in density of the luminiferous medium at different distances from the sun, depending on solar gravitation, and heat, and centrifugal force of the vortices kept up in it by planetary and meteoric motions, is indicated; and it is suggested that a refraction of this inter-planetary atmosphere may produce annual apparent motions in the stars, which may be sensible, although not yet discovered.—As to the preceding expressions for the density of the vibrating medium, all that is known of the values of $\dfrac{\lambda}{A}$ is that they must in all probability be large. If nothing less than 100 be admissible, the mass of a cubic foot of the vibrating medium at the earth's distance could not be less than

$$\frac{1 \text{ lb.}}{77 \times 10^{19}}$$

and near the sun it could be no less than

$$\frac{1 \text{ lb.}}{17 \times 10^{15}}$$

If the earth's velocity (being about $\frac{1}{10200}$ of the velocity of light) be admitted as not too great for the maximum velocity of vibration of plane polarized light, the mass of the luminiferous medium within a sphere concentric with the sun, with radius equal to that of the earth's orbit, might be not more than $\frac{1}{1500}$ of the earth's mass, since the mechanical value of light within that space is about $\frac{1}{1500}$ of that of the earth's motion.

4. Account of Experimental Investigations to answer questions originating in the Mechanical Theory of Thermo-Electric Currents. By Professor W. Thomson.

In this communication the mode of experimenting was described by which the experimental results quoted in the theoretical paper were obtained; and the principal parts of the special apparatus which had been constructed and used in the investigation, were laid before the Royal Society.

5. Dynamical Theory of Heat, Part VI. continued. A Mechanical Theory of Thermo-electric Currents in Crystalline Solids. By Professor W. Thomson.

In this paper the Mechanical Theory of Thermo-electric Currents in linear conductors of non-crystalline substance, first communicated to the Royal Society December 15, 1851, is extended to solids of any form and of crystalilne substance.

It is first proved, that if a solid be such that bars cut from it in different directions have different thermo-electric powers relatively to one another, or to other linear conductors, forming part of a circuit, there must, for every bar cut from it, except in certain particular directions (principal thermo-electric axes), be a new thermo-electric quality, of a kind quite distinct from any hitherto known; giving rise to a reciprocal thermo-dynamic action, which consists of *a difference in temperature at the sides of the bar causing a current to flow longitudinally, when the two ends, being at the same temperature, are connected by a uniformly heated conductor; and a current through the bar causing an absorption and evolution of heat at its two sides, when these are kept at the same temperature.*

The most general conceivable thermo-electric relations of a crystalline solid, or body possessing, inductively or structurally, different physical properties in different directions, are next examined. It is shown how a metallic structure may be actually made up of pieces of different non-crystalline metals, which, taken on a large scale compared with the dimensions of the heterogeneous elements of which it is composed, will be found to exhibit the most general type of thermo-electric directional relations indicated by the abstract investigation; and it is inferred that it would be wrong to limit the general expressions by any particular assumption, even if we only discover simpler types of thermo-electric relations in natural crystals.

The general equations determining the thermo-electric currents in any naturally, inductively, or structurally crystalline solid; resulting either from a completely specified distribution of temperature through it; or from given external appliances of heat, on which, and on the thermo-electric currents themselves, the distribution of heat through the interior will depend; are investigated.

Certain particular applications of the general equations are also made; and the thermo-electric properties of metallic structures (laid before the Society as solids actually possessing the properties referred to), are investigated.

The paper in which this extension of the theory is described, includes a more developed account of the theory of thermo-electric currents in non-crystalline conductors, formerly communicated, than has been hitherto printed; with a simplification in the fundamental equations introduced without hypothesis, by the adoption of a thermometric assumption proposed as the foundation of an absolute scale of temperature, in consequence of thermo-dynamic experiments on air recently made by Mr Joule and the author. It also includes a brief outline of some experimental investigations undertaken to answer questions proposed in the former theoretical communication, and suggested by various considerations which occurred in the course of the research, and by the new part of the theory now communicated to the Royal Society.

7. On the Structure of Diatomacea. By E. W. Dallas, Esq.

The author directed attention to the following list of species, which, although imperfect, exhibits great variety in the forms, shewing the Medway to be very fertile in these organisms:

Epithemia Musculus.
Campylodiscus cribrosus.
Surirella striatula.
„ linearis.
Tryblionella marginata.
Tryblionella Scutellum.
„ punctata.
„ gracilis.
„ acuminata.
Cymatopleura elliptica.
Triceratium Favus.
„ striolatum.
„ undulatum.
Cyclotella Kutzingiana.
„ operculata.
And three species undetermined.
Actinocydus undulatus.
Actinoptychus senarius.
„ septenarius.
„ octonarius.
„ nonarius.
Eupodiscus Argus, 2 vars.
„ radiatus.
„ maculatus.
Coscinodiscus radiatus.
„ minor.
„ eccentricus.
„ Thwaitesii.
And an undetermined species.
Cocconeis Pediculus.
„ Scutellum.
Nitzschia sigmoidea.
„ dubia.
„ reversa.
And an undetermined species.
Navicula elliptica.
Navicula convexa.
„ Westii (?)
„ didyma,
„ pusilla.
„ punctulata.
„ palpebralis.
Pinnularia divergens.
Stauroneis pulchella.
Cocconema parvum.
Pleurosigma balticum.
„ Hippocampus.
„ angulatum.
„ acuminatum.
„ distortum.
Doryphora Amphiceros, vars.
„ Boeckii.
Achnanthes brevipes.
Grammatophora marina (?)
Biddulphia aurita.
Zygoceros rhombus.
Denticella sp.
Orthoseira sp.
Dictyocha.
Bacteriastrum furcatum (?)
„ curvatum (?)

Some of the species in this list have been described as new to Britain by Mr Roper, in a late paper published in the Microscopical Journal. The Coscinodiscus, not named, seems from the description to be the same with that found at the mouth of the Thames, and is an exceedingly beautiful disc. The four species of Actinoptychus are those described by Ehrenberg, and are new British species. They exhibit the strong siliceous cellular tissue underneath the moniliform structure of the surface, as in Actinocyclus. The examples of Triceratium striolatum, and also Zygocerus rhombus, differed somewhat from the figures and descriptions given of them, being provided with spines along the side, and with two spines placed close to the projecting terminations or angles of the valve, and which were always present in the examples that had come under observation. The surfaces of the valves were also seen to be dotted over with small nodules, giving them a very remarkable appearance, and which might be seen to project from the surface when the valve was suitably placed; these appearances might be attributable to a more mature developing of the siliceous structure.

Among the remarkable forms found, although not considered to belong to the Diatomaceæ, are the two varieties of Bacteriastrum, the discs of which, it may be observed, were three or four times the diameter of those described by Mr Shadbolt, from Port Natal, and the radiations more numerous.

Attention was directed to the structure of the Diatomaceæ as affording some of the most beautiful examples of geometric arrangement with which we are acquainted. It was pointed out that there are only three of the regular polygons that can be employed alone to fill up the space about a point in a plane surface, namely, the equilateral triangle, the square, and the hexagon; these forms and their angles are accordingly found to prevail in the structure of the tissues. By constructing the polygons, it was shewn that they arranged themselves in straight lines, determined by the shorter axis of the figures, the quadrilaterals having two directions in which the lines run, and the hexagons three. With the hexagonal structure, when one set of the lines passing through the axis is referred to a centre, the cells then appear to radiate in straight lines from the centre, while the other two directions in which they appear to run will be spiral lines, having a definite character according to the size of the cells. Much of the character of the tissue depends on the position of the axis of the polygon with respect to an axis of the valve,—that is, whether the longer or shorter axis is parallel to it. Mr Smith in his Synopsis has noticed this peculiarity, and in accordance with it has divided his genus Pleurosigma into two sections.

The above arrangements will be found to prevail in the structures of the tissues of the valves, and the influence of the living principle might generally be seen in the repetition of like spaces about a centre in each species, and always in the same numerical relations in each individual of the species, multiples of the numbers 2, 3, and 5, and also 7, seeming to prevail.

These divisions are seen very conspicuously in Actinocyclus and Actinoptychus. In the large species of Coscinodiscus, the number of sectors appeared to be twelve, from the groups of rows at the centre, and in it was shewn the very beautiful arrangement of the cells in radiating and intersecting spiral lines. Eupodiscus Ralfsii was referred to as affording an example of the division of the circle into sectors, within which the lines of cells are arranged symmetrically on each side of a single radiating row, to which the rest are

all parallel. In Eupodiscus maculatus, the disc is divided into ten, but the rows of cells do not converge towards the centre, except one at the side of each sector, to which the others are parallel. From this may be derived the very beautiful and peculiar construction of the Coscinodiscus eccentricus, in which the disc is divided into seven sectors, the rows of cells extending across the valve from each sector to meet similar rows from the second sector beyond.

The following Donations to the Library were announced:—

Archives du Muséum d'Histoire Naturelle. Publiées par les Professeurs de cet établissement. Tome VII., Liv. 1 & 2. 4to. —*From the Museum.*

Actuarial Tables; Carlisle Three-per-Cent. Single Lives and Single Deaths. With Auxiliary Tables. By William Thomas Thomson, F.R.S.E., F.I.A. 4to.—*From the Author.*

On the application of Cast and Wrought Iron for Building Purposes. By William Fairbairn, C.E. 8vo.—*From the Author.*

Jahrbuch der Kaiserlich Königlichen Geologischen Reichsanstalt. 1853. IV. Jahrgang. 8vo.—*From the Institute.*

Denkschriften der Kaiserlichen Akademie der Wissenschaften. Mathematisch-Naturwissenschaftliche Classe. Band VI. 4to.

Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften. Mathematisch-Naturwissenschaftliche Classe. Band XI. 8vo. —*From the Academy.*

Mémoires de l'Académie des Sciences de l'Institut de France. Tome XXIV. 4to.—*From the Academy.*

Memoirs of the Geological Survey of the United Kingdom. British Organic Remains. Parts 1, 2, 3, 4, 6, 7. 4to.

Memoirs of the Geological Survey of Great Britain, and of the Museum of Practical Geology in London. Vol. II. Pts. 1 & 2. 8vo.

Museum of Practical Geology and Geological Survey. Records of the School of Mines and of Science applied to the Arts. Parts 1, 2, 3, 4. 8vo. (With various Maps and Pamphlets.) —*From H. M. Government.*

Journal of the Geological Society of Dublin. Vol. VI., Part 1. 8vo.—*From the Society.*

The Assurance Magazine, and Journal of the Institute of Actuaries. Vol. IV., Part 3. 8vo.—*From the Institute.*

The American Journal of Science and Arts. Vol. XVII., No. 50. 8vo.—*From the Editors.*

Comptes Rendus hebdomadaires des Séances de l'Académie des Sciences. Mai 1853–Mai 1854. 4to.—*From the Academy.*

Memorie della Reale Accademia delle Scienze di Torino. Tom. XIII. 4to.—*From the Academy.*

Bulletins de la Société de Géographie. Tome V. 8vo.—*From the Society.*

Annales de l'Agriculture et de l'Industrie de Lyon. Tome III. 8vo.—*From the Society.*

Annales de l'Observatoire Physique Central de Russie. 1851. 2 Tomes, 4to.—*From the Observatory.*

Journal of the Horticultural Society of London. Vol. VIII., Part 4. 8vo.—*From the Society.*

Monday, 17*th April* 1854.

Monday, 1*st May* 1854.

PROCEEDINGS

OF THE

ROYAL SOCIETY OF EDINBURGH.

SESSION 1854–5.

CONTENTS.

Monday, 4th December 1854.

[*Turn over.*

Tuesday, 2d January 1855.

Monday, 15th January 1855.

Monday, 5th February 1855.

Monday, 19th February 1855.

[*For continuation of Contents, see page 3 of Cover.*